Grading Standards
Earth Systems 3209
June 2007

Pre-Marking Appraisal

Overall, the June 2007 was considered a fair exam with a good sampling of unit outcomes. The exam was well designed and of reasonable length. The difficulty level was fine with the appropriate mix of level 1, 2, and 3 questions.

The marking board did look closely at three questions from Part 1 of the exam.

#35: Associate markers pointed out that the current textbook recognizes the amount of energy released as 32 times greater with each increase in Richter magnitude. Other texts and what was accepted in the curriculum guide was a 30 times increase with each increase in Richter magnitude. It was agreed that choice "D" was the best answer.

#40: Response C and D were was noted to be the same. Response "A" was the correct answer to this question, therefore the fact that both choices "C" and "D" were the same would not influence the outcome of this question.

#58: It was noted by associate markers that the numbering for question #58 in the multiple choice was repeated, with #59 omitted, followed by #60 (ie: #58, #58, #60). The second #58 on the exam should have been numbered #59, but students logically shaded their responses sequentially on the bubble sheet provided with #59 shaded in the sequence of answers from #58 to #60.

The constructed response questions were also considered both fair and clear. There was some concern however with regard to one question below;

#63(g) Associate markers noted that the contact metamorphism associated with igneous rock unit "E" was not located in the correct position in the diagram. Answers to question 63 (g) parts (ii) & (iii) was not influenced by contact metamorphism of rock unit "E". The answer to part (i) of this question may have been influenced by the position of the contact metamorphism. For this reason, the marking board decided to accept the sequence of events where igneous rock unit "E" could be included at the beginning of the sequence or after rock unit "D" and before geologic feature "K" as seen below: (E, J, I, H, F, D, K, C, B, A, G "OR" J, I, H, F, D, E, K, C, B, A, G). Both of these sequences were accepted as correct.

Post Marking Report:

Marking Standard and Consistency

Marker reliability was checked by obtaining a random sample of 55 papers that were graded and marks assigned to each question and recorded on a separate sheet of paper. The 55 exams were put back into the original stack of exams and evaluated 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. Overall, marks from the random sampling compared favourably when the exams were evaluated again.

Overall performance in the Earth Systems 3209 examination increased from June 2006 to June 2007. As in the 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.

PART II
Total Value: 40%

Constructive Response/Common Errors

Value

2% 61.(a) The information below was collected from radioactive isotopes found in two different rock samples from a volcanic island.

Rock sample	Half-life (million years)	Amount of parent material remaining
A	2.5	$\frac{1}{128}$
B	4.3	$\frac{1}{16}$

(i) Determine the number of half-lives that have passed for each sample. Show your workings.

Determine the number of half-lives. **1 mark** for sample A and **1 mark** for sample B.

For **Sample A** the half lives is 7, simply using a chart or using the idea that... ½ x ½ x ½ x ½ x ½ x ½ x ½ = 1/128 so 7 half lives OR $^1/_1 \rightarrow {}^1/_2 \rightarrow {}^1/_4 \rightarrow {}^1/_8 \rightarrow {}^1/_{16} \rightarrow {}^1/_{32} \rightarrow {}^1/_{64} \rightarrow {}^1/_{128}$ } 7 arrows so 7 half lives
For **Sample B** the half lives is 4. Again, simply using a chart or using the idea that... ½ x ½ x ½ x ½ = 1/16 so 4 half lives OR $^1/_1 \rightarrow {}^1/_2 \rightarrow {}^1/_4 \rightarrow {}^1/_8 \rightarrow {}^1/_{16}$ } 4 arrows so 4 half lives

(ii) State which rock sample is older. Show workings to justify your answer.

Determine which sample is older. **1 mark** for calculations and **1 mark** for statement.

Age = Number of Half Lives x Time of One Half Life	
Sample A Age = 7 x 2.5 Million years Age = 17.5 million years	Sample B Age = 4 x 4.3 Million years Age = 17.2 million years
Sample A is 300,000 years (.3 Million years) older than Sample B	

Commentary on Response
Many students did not attempt this item.

Common Errors

Students:

- incorrectly calculated the number of half-lives (stopped at six for sample A and three for sample B)
- incorrectly calculated the ages of samples A and B
- identified sample B as older than sample A because the corresponding half-life of sample B is larger

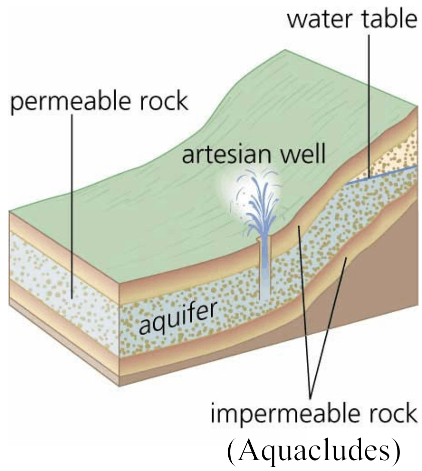
Value

2% 62.(a) With the aid of a fully labelled diagram, briefly describe the conditions necessary to produce a flowing artesian well.

Diagram of a flowing artesian well outlining the conditions; inclined aquifer confined between impermeable aquacludes, and a well drilled below the water table, is seen below.

½ mark Aquifer confined between two aquacludes.

½ mark Well positioned below the water table (pressure surface).



The three conditions that are necessary for this to be a flowing artesian well are:

1. There must be an inclined aquifer.
2. The aquifer must be confined between two impermeable aquacludes (aquatardes).
3. The well must be drilled somewhere below the water table (pressure surface) for it to be a flowing artesian well.

Any two of these three points earned **1 mark** on this question (**½ mark** for each point).

Commentary on Response

Many students demonstrated a poor understanding of artesian wells. Diagram was poorly drawn and poorly illustrated.

Common Errors:

Students:

- failed to label pressure surface (water table) within the diagram
- positioned well above the pressure surface (water table)
- reversed the labelling of aquaclude and aquifer in the diagram
- provided poorly illustrated diagrams of an artesian well.

Value

2% 62.(b) Describe how the interaction of two of Earth's spheres resulted in the formation of oil.

The main spheres involved here are the biosphere and the geosphere but they may also include the hydrosphere. A living organism dies and is quickly buried by sediment. The organism is cut off from air and as it is buried deeper and deeper, heat and pressure along with the activity of anaerobic bacteria, converts former organic materials to keragen and finally to oil. One connection of the spheres show the biosphere as the living organism, the geosphere as the sediments that bury the organisms and porous rock that contains the oil, and the hydrosphere may be what the organisms were living in.

1 mark for stating or alluding to the biosphere and geosphere (also hydrosphere).

1 mark for describing the formation of oil in relation to spheres.

Common Errors:

Students failed to make reference to two of Earth's spheres.

Value

2% 63.(a) Two mineral samples that look similar are known to be quartz and calcite. Explain two ways how you can distinguish quartz from calcite.

The best tests that could be used to distinguish between quartz and calcite include:

1) Hardness test would indicate that quartz is harder than calcite (hardness of 7 and 3, respectively).
2) Cleavage test would indicate that quartz has no cleavage (fracture) while calcite has a perfect cleavage in three directions.
3) Acid test indicates that calcite (carbonate) reacts or fizzes when exposed to acids, whereas, quartz would not react or fizz.
4) Crystal form would show calcite having a rhombohedral structure while quartz displays a hexagonal structure.

1 mark for identifying the test used (**½ mark** for each test).

1 mark for explaining how each test distinguishes between quartz and calcite.

Common Errors:

Students failed to identify how the appropriate test would indicate if the mineral was quartz or calcite.

Value

3% 63.(b) Distinguish between igneous, metamorphic, and sedimentary rocks by completing the table below.

Rock names were also accepted to describe the rock type and a variety of distinguishing features were accepted as correct as referenced in the table below.

Rock	Type	Distinguishing feature
	Sedimentary (Conglomerate)	- rounded particles - any sedimentary feature - cementing
	Metamorphic (gneiss) (Schist)	- folding - foliation - banding
	Igneous (Granite) (Diorite) (Gabbro)	- crystals - coarse grained

1½ marks - **½ mark** for stating each of the three rock types.

1½ marks - **½ mark** for identifying one feature of each rock type.

Common Errors:

Students:

- commonly mislabeled the metamorphic diagram as sedimentary and the sedimentary diagram as igneous
- failed to identify acceptable features for each rock type

Value

2% 63.(c) Describe two sedimentary features that can be used to determine if a sedimentary bed has been inverted (i.e., overturned).

Students could reference several sedimentary features to correctly answer this question. Features referenced may include, graded bedding, fossils, mud cracks, inclusions, cross bedding and ripple marks. The following descriptions would suggest that a sedimentary sequence was inverted (overturned).

Graded Bedding: the coarser sediments are located toward the top and the finer sediment toward the bottom of a sedimentary bed.
Fossils: shells are found with their open side (concave) up.
Mud cracks: the cracks (V-shape) within the mud would open downward or the mud cracks would curl downward.
Inclusions: the inclusions (rock fragments) are found within the sedimentary layer above the source rock, but if the source rock is located above the layer with the included fragments, this suggests that the sedimentary sequence has been overturned.
Cross Beds: the inclined cross beds would gently bend (be slanted) upward with the base of the inclined cross beds intersecting layers below at a higher angle.
Ripple marks: the crests of the ripples would be pointing downwards. Also, sediment between the ripples would be located on the lower side of the ripples.

1 mark **½ mark** for stating two of the sedimentary features used.

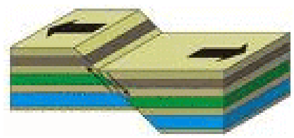
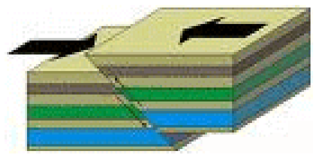
1 mark **½ mark** for describing how each feature indicates an inverted sedimentary bed.

Commentary on Response:
Many students did not attempt this item.

Common Errors:
Students referred to an overturned bed as being smooth on top and rough on the bottom.

Value

3%   63.(d) Using arrows to indicate the direction of forces associated with each fault, draw diagrams of a normal, reverse, and transform fault.

		
normal	reverse	transform

1½ marks **½ mark** for identifying the forces associated with each fault.

1½ marks **½ mark** for identifying relative motion of rocks associated with each fault. Correct diagram of each fault.

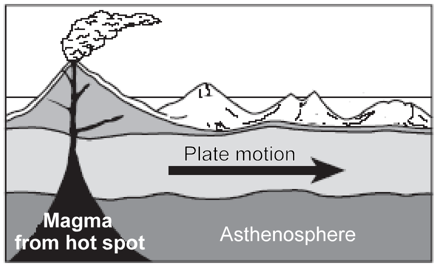
Common Errors:

Students:

- reversed the direction of forces associated with normal and reverse faults
- drew a normal fault for a reverse fault and vise versa. Thereby confusing the two types of faults.

Value

2% 63.(e) With the aid of a labelled diagram, explain how hot spots can be used to support the Theory of Plate Tectonics.



Tuzo Wilson's explanation of hot spots supported his theory of plate tectonics. A hotspot is a stationary heat source within Earth that supplies magma to active volcanoes on the ocean floor. Scientists recognized that the age of these volcanic islands and seamounts increase the further you move away from the active volcano located directly above the hotspot. The idea of a moving ocean floor (seafloor spreading) over a stationary hotspot would explain the increasing age of the volcanic islands and would also support the theory of plate tectonics which suggests that the ocean floor is not stationary.

½ **mark** for indicating a chain of volcanic islands on the diagram.

½ **mark** for indicating the direction of plate motion.

½ **mark** for stating that the hot spot was stationary and plate moved over the hotspot.

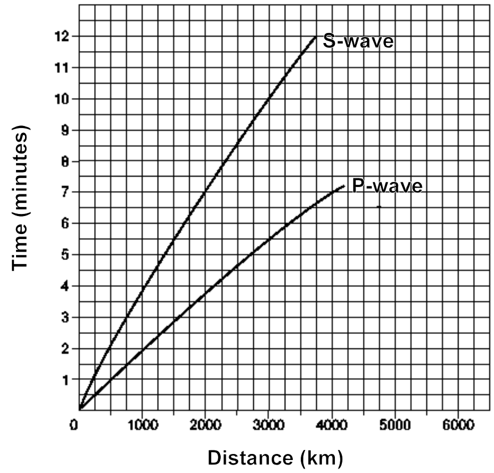
½ **mark** for stating that the age of the islands increased as distance from the hotspot increased.

Common Errors:

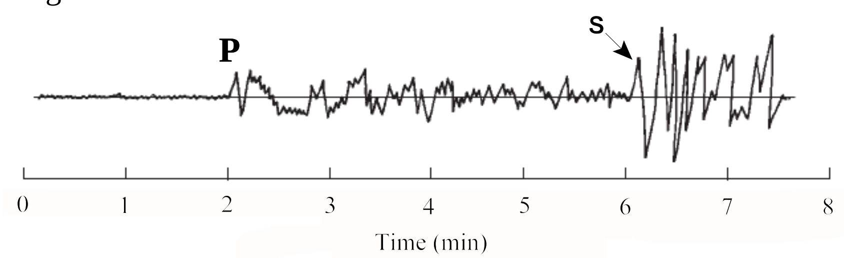
Students mislabeled the diagram with respect to plate motion, arrow pointing in wrong direction.

Value

4% 63.(f) The travel-time graph below shows the arrival times of P- and S-waves at a seismograph station.



(i) The seismogram below was recorded at the seismic station. Draw and label an arrow on the seismogram below to indicate the arrival time of the P- waves at the recording station.



1 mark for indicating on the seismogram when the P-wave arrived (2 minutes).

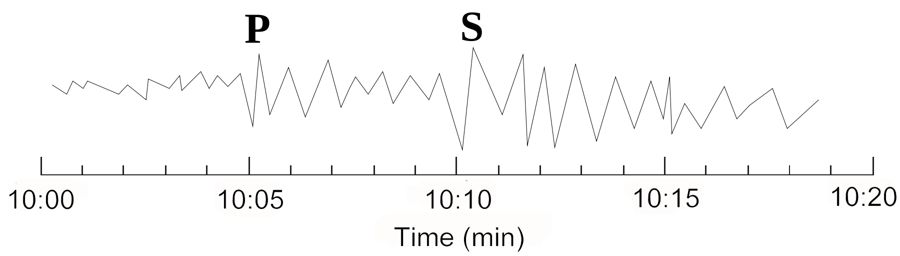
(ii) Determine the difference in the arrival time between the two waves.

1 mark for stating 4 minutes. (6 min. - 2 min.)

(iii) Determine the distance from the epicentre to the recording station.

1 mark for stating a distance between 2250 km and 2750 km.

(iv) Draw a seismogram on the scale below that is obtained from a recording station located 3500 km from the epicentre. Assume that the P-waves arrived at 10:05.



½ mark for indicating the arrival of P-wave on seismogram as seen above.

½ mark for indicating the arrival of S-wave on seismogram as seen above.

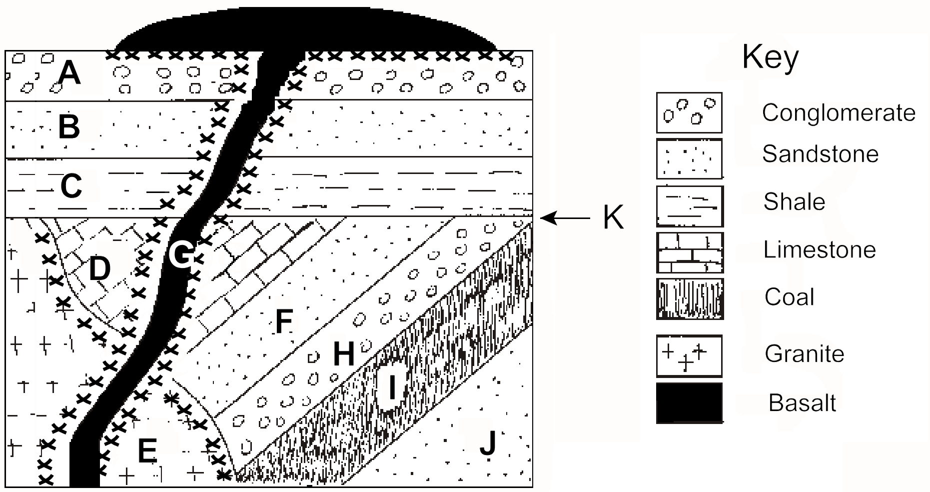
Common Errors:

Students:

- did not know how to read the travel-time graph associated with the question
- who displayed an understanding of the travel-time graph, misread the vertical scale. Often the vertical scale was read as one block equal to one minute, whereas, two blocks is equal to one minute.
- failed to pinpoint the time when the P-wave arrived in part (i).

Value

4% 63.(g) Use the diagram below to answer the questions that follow.



(i) List the geologic events, represented by letters A to K, from oldest to youngest.

Oldest ——————→ *youngest*

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Answer: J, I, H, F, D, E, K, C, B, A, and G.

1 mark for sequencing geologic events J, I, H, F, D, and E.

1 mark for sequencing geologic events K, C, B, A, and G.

(ii) Which type of unconformity is represented by K? ____________________

1 mark for stating angular unconformity.

(iii) Explain how you know which letter identifies the oldest igneous rock unit.

½ mark for stating that igneous rock unit “E” is older than igneous rock unit “G”.

½ mark for stating that igneous rock unit “E” is older because Unit “G” cuts rock unit “E” (law of cross cutting) or igneous rock unit “G” burns (contact metamorphism) rock unit “E”.

Commentary on Response:
Students misread part (iii) and did not realize that the question asked, ***"****which* ***igneous*** *rock unit is the oldest****,"*** instead the majority of the answers by students stated that rock unit "J" was the oldest. While "J" is the oldest, it is not the oldest igneous rock unit.

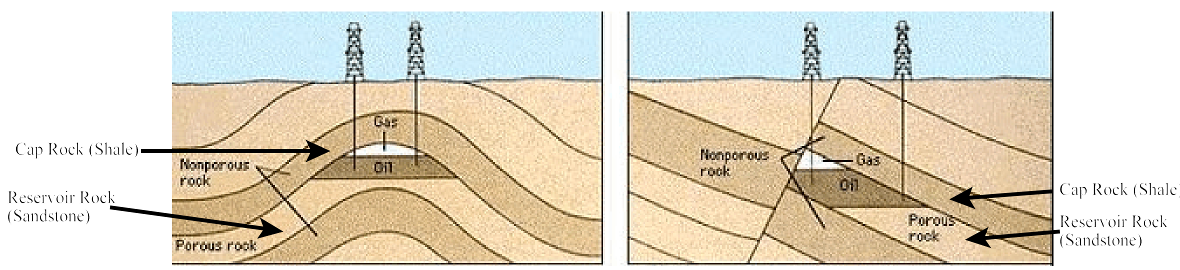
Common Errors:

Students:

- suggested the geologic feature indicated by "K" is erosion, which is the ***process*** that forms feature "K" (angular unconformity)
- indicated that rock unit "E" is oldest because it is located below the tilted layers
- suggested that rock unit "J" is oldest because of the law of superposition
- did not realize that the question (part (iii)) specified igneous rock unit, referring to rock unit "E" or "G".

Value

2% 63.(h) A large oil reservoir was discovered in a deformed sedimentary basin located in a shallow ocean. Use a labelled diagram to show how the oil is trapped and indicate on the diagram the best location for drilling a well.



Deformed sedimentary basins can display several structures, such as, folds, faults, salt domes, stratigraphic traps, etc., in which oil and gas can be trapped. The most common include folded anticline traps and faulted traps as seen in the diagrams above.

Students received ½ **mark** for labelling the following features in the diagram;

- cap rock (or aquaclude, or shale)
- reservoir rock (or aquifer, or sandstone)
- water, oil, gas sequence within reservoir rock
- best location for drilling

Common Errors:

Students:

- did not indicate a faulted or folded (deformed) structure in their diagram. Many diagrams displayed flat, horizontal layers.
- did not indicate on their diagram the best place to drill a well
- reversed the water, oil, gas sequencing in their diagram.

Value

2% 63.(i) Explain how economic minerals are concentrated in hydrothermal deposits.

In a hydrothemal deposit, fluids (water) moving through the crust get heated because they are near an intrusion or because they are deep beneath Earth's surface (due to the geothermal gradient). These heated fluids can dissolve metallic ions in the rock and carry them in solution. As the heated water moves through cracks in the rock, it cools and the dissolved metals in the fluid may come out of solution (precipitate) and concentrate in veins. These veins often contain minerals rich in gold or copper.

1 mark for stating fluids (water) get heated and dissolves metals.

1 mark for stating that metals move with fluid, precipitates (falls out of solution) and concentrates (accumulates) in veins.

Commentary on Response

Many students did not attempt this item.

Common Errors:

Students:

- described the process of formation for evaporite and placer deposits
- focussed on sediment carried and deposited by streams.

Value

2% 63.(j) Explain how both regional and contact metamorphism can occur at a subduction zone.

Subduction boundaries have two tectonic plates colliding which causes extreme pressure. As one tectonic plate subducts beneath another to great depths within the mantle, melting occurs. Also as one tectonic plate subducts, water is carried down with the descending plate. This outlines the three conditions associated with metamorphism, pressure, heat, and chemically active fluids. Areas within the over-riding (continental) tectonic plate coincide with mountainous areas which experience high pressure and high heat which causes regional metamorphism. Areas immediately surrounding the rising molten magma and lava at the surface, experience high heat which causes contact metamorphism.

1 mark for identifying how high heat and high pressure is associated with subduction boundaries.
1 mark for identifying how heat and pressure cause regional metamorphism and heat causes contact metamorphism.

Commentary on Response

Many students did not attempt this item.

Common Errors:

Students failed to relate the conditions for metamorphism to subduction.

Value

3% 64.(a) Explain how a meteorite impact could cause a mass extinction on Earth today.

One idea to explain the mass extinction in the past (approximately 66 million years ago), centered around a meteorite impact at the end of the Mesozoic period. The collision of a meteorite with Earth would cause huge amounts of dust/ash and other materials to be ejected into the atmosphere. This would then prevent the sun's energy from reaching Earth resulting in a drastic change in the climate contributing to a cooling of global temperatures. The lowering of global temperatures and the reduction in the amount of incoming solar energy would cause most plant life to die out. Animals that could not adapt to this quick change in climate and the resulting loss of food supply through a reduction of plant life (collapse of the food chain) would die. The concept of uniformitarianism suggests that such an event could again happen on Earth in the future and that life on Earth would respond to such an event as it did in past history (end of Mesozoic) resulting in mass extinctions of plant and animal life.

1 mark for relating meteorite impact to an increase ash and dust in atmosphere.
1 mark for indicating blocking solar energy and changing global climate.
1 mark for stating that plants and animals die out as a result (mass extinction).

Common Errors:
Students related uniformitarianism to meteorite impact in past, but did not explain how extinction was connected to this event.

3% 64.(b) Using Plate Tectonic Theory, explain how the island of Newfoundland formed.

Many years ago prior to the existence of Pangaea, the eastern region of Newfoundland was thought to be a part of the African continent and the western region of Newfoundland was thought to be a part of the North American continent. They were separated by the Iapetus Sea. A volcanic island arc formed between the two continents as convergence caused the sea to close. With time the two continents collided and sandwiched the oceanic volcanic rocks between the landmasses which formed the central region of present day Newfoundland. Later Pangaea separated and the split occurred east of Newfoundland leaving behind a part of the African plate.

1 mark for suggesting the African plate collided with North American plate.
1 mark for identifying ocean floor volcanic rocks forming the central region.
1mark relating the three regions to plate tectonics and how part of the African plate was left behind when Pangaea split.

Common Errors:

Students:

- failed to relate plate tectonics to the formation of Newfoundland
- related the formation of Newfoundland to the continental drift theory, instead of the plate tectonic theory.

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

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
1	D	1.3	21	1.5	76.1
2	C	42.1	2.4	53	2.5
3	C	4.9	5.7	83.6	5.8
4	A	71.9	8.3	12.2	7.3
5	C	1	6.7	68.9	23.2
6	C	14.7	2.9	64.4	17.6
7	D	0.8	6.7	13.4	79.2
8	C	5.7	5.4	88.3	0.6
9	B	20.5	67.6	4.8	6.7
10	A	90.7	3.7	4	1.6
11	A	77.2	10.8	10.1	1.9
12	B	34.8	61.7	2.1	1.4
13	A	53.8	15.6	22.8	7.7
14	C	11.1	22	62	4.9
15	D	0.8	0.3	7.6	91.4
16	C	0.5	0.4	98.9	0.3
17	C	18.8	0.9	73.7	6.7
18	A	40.3	48.7	4.5	6.2
19	A	96.1	2	1.6	0.1
20	C	28	14.4	45.7	12
21	C	13.1	18.1	51.8	16.9
22	B	17.3	69.9	7.2	5.5
23	A	77.8	6.4	12.6	3.1

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
24	C	3.7	7.2	84.9	4.2
25	B	16.8	59.7	8.4	14.9
26	C	17.5	23	57.6	1.9
27	B	11.3	33	40.8	14.7
28	B	12.6	85.4	1.3	0.8
29	C	16	15.5	52.9	15.5
30	B	10.8	63.1	7.9	18.1
31	A	50.1	3.1	6.2	40.4
32	B	5.4	55.9	22.2	16.1
33	A	39	50.1	4.4	6.2
34	B	44.8	27	10.8	17.4
35	D	24.8	18.6	18.5	38
36	A	65.2	32.2	2	0.5
37	B	6.9	79.7	9.6	3.8
38	C	5.3	5.3	77.2	12.2
39	A	73	2.3	1	23.7
40	A	54.4	33.2	10.1	1.9
41	D	48.9	1.3	2.8	47.1
42	C	5.8	6.9	84.9	2.1
43	D	2.3	1.4	18.9	77.3
44	A	86.4	6.7	2.9	3.8
45	D	19.3	14.1	13.6	53
46	B	14.5	52	22.2	11.1
47	D	6.3	6.8	17.9	68.9

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
48	C	1.3	3.9	87.3	7.6
49	A	68.6	7.8	10.6	12.8
50	D	7.4	13.5	18	60.8
51	B	11.7	53	21.7	13.5
52	D	2.8	20.2	5.3	71.7
53	D	6.5	10.6	12.8	69.6
54	B	7.9	61.1	28.6	2.3
55	B	24.9	52.8	6.9	15.4
56	C	9.9	18	57.9	14
57	B	6.8	81	11.1	1
58	A	45.1	33.8	7.4	13.6
59	B	1.5	92.1	5.2	1.1
60	C	2.3	5.4	88	4.3

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

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

Item	Students Completing Item	Value	Average
61	841	4%	2.36
62.(a)	841	2%	0.98
62.(b)	841	2%	1.36
63.(a)	841	2%	1.35
63.(b)	841	3%	1.37
63.(c)	841	2%	0.72
63.(d)	841	3%	1.41
63.(e)	841	2%	0.94
63.(f)	841	4%	2.29
63.(g)	841	4%	2.17
63.(h)	841	2%	1.12
63.(i)	841	2%	0.61
63.(j)	841	2%	1.09
64.(a)	841	3%	2.13
64.(b)	841	3%	1.72