EXAM MARKING KEY

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Section 1

Question 1a (Outcome 1, aspect 1)

4-5	L6	• Interprets data, using several simple abstract science concepts and explains the relationships between them, then draws conclusions which are consistent with the data. • Scientifically relate it to the question and critically evaluate the data e.g. scale only 0.2º temp difference, 4.5 watts per square meter irradiance difference.
2-3	L5	• Interprets graph, using several simple abstract scientific concepts that are consistent with data. • Explain patterns in the data in terms of abstract science concepts but don’t link them together.
1	L4	• Interprets graph, using a simple abstract science concept.
	ne	Incorrect response or no response provided.

Question 1b (Outcome 1, aspect 3)

4-5	L6	• Interprets data, using several simple abstract science concepts and explains the relationships between them, then draws conclusions which are consistent with the data. • Scientifically relates it to the question and critically evaluates the data.
2-3	L5	• Interprets graph, using several simple abstract scientific concepts that are consistent with data. • Explain patterns in the data in terms of abstract science concepts but do not link them together.
1	L4	• Interprets graph, using a simple abstract science concept.
	ne	Incorrect response or no response provided.

Question 1c (Outcome 3, aspect 3)

7-8	L8	• Critically evaluates their use of principles/theories in relation to each other. • Complex abstract multi-structural thought.
5-6	L7	• Evaluates complex theories and the predictions of others’ about future environmental changes in terms of their consistency with the evidence from past environments. • Conceptualises at a level extending beyond what has been dealt with in the actual teaching.
3-4	L6	• Interprets past evidence, using several simple abstract science concepts and explains the relationships between them and then draws conclusions which are consistent with the evidence. • Scientifically relates it to the question and critically evaluates the data.
1-2	L5	• Interprets the evidence, using several simple abstract scientific concepts that are consistent with the evidence for environmental change based on past and present to predict future environmental change. • Explain patterns in the evidence in terms of abstract science concepts but do not link them together.
ne		Gives insufficient or incorrect response.

Question 2 (Outcome 2 aspects 1 and 2 and Outcome 1, aspect 4)

Outcome 2

3-4	L7	• Provides a quantitative account of materials and energy as they are cycled through reservoirs and explain how these have changed over time. • Evaluates quantitatively material and energy transformations through reservoirs from macroscopic to microscopic levels. •
1-2	L6	• Using several simple abstract science concepts, explains that throughout the dynamic interrelationships in reservoirs materials are conserved. • Explains how changes in a reservoir can affect the properties of other reservoirs, using several simple abstract science concepts and the relationships between them. •
	ne	Incorrect response provided.

Outcome 4

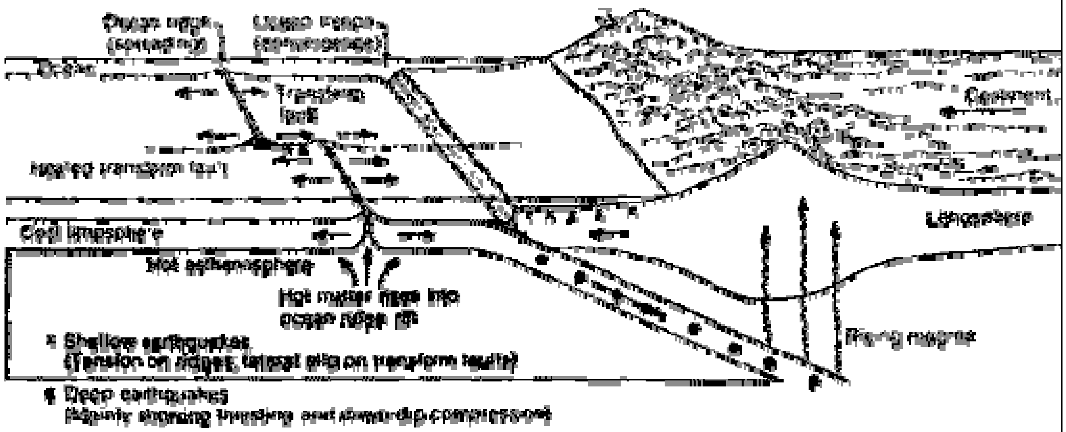
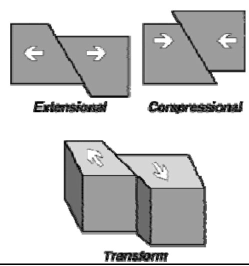
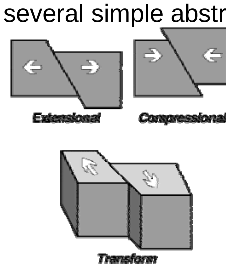
3-4	L7	• Evaluates quantitatively material and energy transformations through reservoirs from macroscopic to microscopic levels using appropriate scientific terminology and abstract conceptual models to explain, interpret and make predictions about interactions between energy and matter in physical phenomena.
1-2	L6	• Discusses the properties, using several simple abstract science concepts and explains the relationships between them, then draws conclusions which are consistent with which rocks are found in each layer. • Scientifically relates it to the question and critically evaluates the data.
	ne	Incorrect response provided.

Question 3a (Outcome 2, aspects 1 and 2)

4-6	L5 A	• Explains how the properties of Earth materials depend on their chemical and physical composition, using several simple abstract scientific concepts. • ***Island arc/magmatic arc****: In a typical 'island-arc' environment, volcanoes lie along the crest of an arcuate, crustal ridge bounded on its convex side by a deep oceanic trench. The granite or granite-like layer of the continental crust extends beneath the ridge to the vicinity of the trench. Basaltic magmas, generated in the mantle beneath the ridge, rise along fractures through the granitic layer. These magmas commonly will be modified or changed in composition during passage through the granitic layer and erupt on the surface to form volcanoes built largely of non-basaltic rocks -- Excerpt from: Tilling, 1985, Volcanoes: USGS General Interest Publication* Explains that the Earth System is dynamic and materials and energy interact within and between reservoirs, using several simple abstract scientific concepts.
	B	***Subduction zone/convergent margin****: Subduction zones are the flip side of mid-ocean ridges in plate tectonics. They are destructive plate boundaries - sites where it is inferred that plates are taken back down into the asthenosphere. The evidence for their existence largely comes from seismology. Destructive plate margins are marked by, commonly explosive, volcanism. Theoretically the volcanism could be due to a number of processes. But crucially, the volcanoes are found above subducting slabs which have reached depths of 120-160 km. This relationship suggests that it is not the slab itself that melts (its too cool at these depths) but from fluids being driven by metamorphic reactions in the slab reacting with the over-riding mantle wedge. As rocks are pressurised by burial or heated up their chemical constituents can recombine into new compounds (minerals). The association of minerals (called facies) for specific bulk chemistry are diagnostic of particular conditions of pressure and temperature. This diagram illustrates how different facies reflect different depths for the temperature-depth relationship typical of subduction zones.* *The composition of igneous rocks varies - creating volcanic island arcs in oceanic crust above subduction zones and 'Andean-style' cordillera in continental crust above subduction zones. The variation in part represents the role of re-melting continental crust. However, the formation of island arcs can be hugely variable - depending on how the mantle melts and how effectively the magma passes upwards to the surface. The rising magma can partly solidify (called fractional crystallisation) and can become contaminated from the material through which it ascends. The very deepest parts of the former island arc contain metamorphosed igneous rocks indicative of being buried to depths in excess of 30 km. These rocks - called granulites include garnets that can reach many cm across. Subduction results from the difference in density between lithosphere and underlying asthenosphere. Where lithosphere is denser than asthenospheric mantle, it can easily sink back into the mantle at a subduction zone; however, subduction is resisted where lithosphere is less dense than underlying asthenosphere. Whether or not lithosphere is more or less dense than underlying asthenosphere depends on the nature of the associated crust. Crust is always less dense than asthenosphere or lithospheric mantle, but because continental crust is always thicker and less dense than oceanic crust, continental lithosphere is always less dense than oceanic lithosphere. Oceanic lithosphere is generally denser than asthenosphere but continental lithosphere is lighter. Exceptionally, the presence of the large areas of flood basalt that are called large igneous provinces (LIPs), which result in extreme thickening of the oceanic crust, can cause some sections of older oceanic lithosphere to be too buoyant to subduct. Where lithosphere on the down going plate is too buoyant to subduct, a collision occurs, hence the adage 'Subduction leads to orogeny.'*

	C	***Mid-ocean ridge/divergent margin/spreading centre:*** *The mid-ocean ridge system forms the longest continuous, volcanic mountain range on Earth. Even the combined length of the Andes, the Rockies, and the Himalayas is small compared with the length of the mid-ocean ridge system. This amazing, underwater mountain chain stretches for over 70,000 km! It is the most active volcanic mountain chain on the Earth, generating about 20 cubic kilometres of magma each year. In the context of plate tectonics, the critical process that has shaped the Earth and its continents, a mid-ocean ridge represents a boundary between two lithospheric plates. These plates are moving away from each other, or spreading apart. As hot mantle material from deep within the Earth rises, it melts, and the magma erupts at the mid-ocean ridges, where new seafloor, or oceanic crust, is created. This is called seafloor spreading. As molten rock cools, different sorts of crystal form in it. The types of crystals depend on the chemical composition of the rock. For example, magnesium-rich rocks often contain many crystals of a greenish mineral called "olivine." The size of the crystals depends on the rate of cooling: the slower it cools, the larger the crystals can grow before the rock solidifies. Molten rocks that cool very rapidly contain only tiny crystals, or none at all (e.g. obsidian). Granite is an example of a rock that has cooled fairly slowly: many crystals are big enough to see with the naked eye. Basalt has a different chemical composition than granite (it contains less silica), and has cooled faster. Hot fluids circulate in the crystal rocks in volcanic zones. Many different minerals are dissolved in these fluids because they are so hot. As they near the surface and mix with seawater, minerals precipitate out of solution. Humans value some of the minerals: for instance, gold, copper, nickel, cobalt and manganese are sometimes found in large quantities near mid-ocean ridges. But mining them are not straightforward when they are found below several kilometres of overlying ocean, far from land.*
1-3	L4 A	• Explains that the gross structure of the Earth can be described in terms of reservoirs. Describes processes that shape the local landscape that have been experienced or reported, in terms of a non-observable property or simple abstract science concept. ***Island arc/magmatic arc****: In a typical 'island-arc' environment, volcanoes lie along the crest of an arcuate, crustal ridge bounded on its convex side by a deep oceanic trench. The granite or granitelike layer of the continental crust extends beneath the ridge to the vicinity of the trench. Basaltic magmas, generated in the mantle beneath the ridge, rise along fractures through the granitic layer.* • Explains that change occurs as a result of interaction between two reservoirs, this may have been experienced or reported, in terms of a non-observable property or simple abstract science concept.
	B	***Subduction zone/convergent margin****: Subduction zones are the flip side of mid-ocean ridges in plate tectonics. They are destructive plate boundaries - sites where it is inferred that plates are taken back down into the asthenosphere. The evidence for their existence largely comes from seismology. Destructive plate margins are marked by, commonly explosive, volcanism.*
	C	***Mid-ocean ridge/divergent margin/spreading centre:*** *In the context of plate tectonics, the critical process that has shaped the Earth and its continents, a mid-ocean ridge represents a boundary between two lithospheric plates. These plates are moving away from each other, or spreading apart. As hot mantle material from deep within the Earth rises, it melts, and the magma erupts at the mid-ocean ridges, where new seafloor, or oceanic crust, is created. This is called seafloor spreading.*
	ne	Incorrect response provided.

Question 3b (Outcome 2, aspects 1 and 2)

4	L7	• Evaluate quantitatively material and energy transformations through reservoirs from macroscopic to microscopic levels. 
3	L6	• Using several simple abstract science concepts, explains that throughout the dynamic inter-relationships in reservoirs materials are conserved. • Explains how changes in a reservoir can affect the properties of other reservoirs, using several simple abstract science concepts and the relationships between them. 
1-2	L5	• How the properties of Earth materials depend on their chemical and physical composition, using several simple abstract scientific concepts. • Explains that the Earth System is dynamic and materials and energy interact within and between reservoirs, using several simple abstract scientific concepts. 
	ne	Incorrect response provided.

Question 4 (Outcome 4 aspects 1,2,and 3)

7-8	L8	• Critically evaluates their use of principles/theories of sustainable management of resources to interpret and explain balance, cycles and equilibrium in systems as a whole in relation to enhancing quality of life and in relation to each other.
5-6	L7	• Can conceptualise at a level extending beyond what has been dealt with in the actual teaching. • Can generalise to a new area, reflects and apply theories to explain the interrelationship between Earth's resources and quality of life. • Can conceptualise at a level extending beyond what has been dealt with in the actual teaching. • Develop and evaluate management plans for sustainable management in their region to contribute to the positive development of their region
3-4	L6	• Explains the interrelationship between Earth resources and quality of life, using several simple abstract science concepts and the relationships between them • Explain and apply an understanding of earth and environmental science to make decisions about practices that affect social, environmental and economic management, and evaluate those decisions, using several simple abstract science concepts and the relationships between them. • Explain, formulate and assess a plan specifically intended to address sustainable management of resources in their region, using several simple abstract science concepts and the relationships between them
2	L5	• Explains the interrelationship between Earth resources and quality of life, using several simple abstract scientific concepts. • Explain and assess reasons for differing opinions in sustainable practice and how these affect social, environmental and economic management, using several simple abstract scientific concepts. • Explains how particular decisions and actions are deemed responsible, and assesses their appropriateness for sustainable management in the broader community using several simple abstract scientific concepts.
1	L4	• Explains the interrelationship between Earth resources and quality of life that have been experienced or reported, in terms of a non-observable property or simple abstract science concept.
	ne	Gives response but does not provide supporting explanation, or gives no response.

Question 5 (Outcome 4, aspect 2)

7-8	L7	Can conceptualise at a level extending beyond what has been dealt wit in the actual teaching. Demonstrate a willingness to rework their own understanding of earth and environmental science as a result of ethically evaluating regional decisions about practices that affect social, environmental and economic management.
5-6	L6	Explain and apply an understanding of earth and environmental science to make decisions about practices that affect social, environmental and economic management, and evaluate those decisions, using several simple abstract science concepts and the relationships between them.
3-4	L5	Explain and assess reasons for differing opinions in sustainable practice and how these affect social, environmental and economic management, using several simple abstract scientific concepts.
1-2	L4	Explains, recognises and suggests reasons for differing opinions in sustainable practice and how these inform and influence social, environmental and economic management, in terms of a non-observable property or simple abstract science concept
	ne	Gives response but does not provide supporting explanation, or gives no response.

Question 6a (Outcome 2 aspects 1 and 2)

7-8	L7	Can conceptualise at a level extending beyond what has been dealt with in the actual teaching. Understand and evaluate the interrelationships between microscopic changes in and between reservoirs and the macroscopic processes that drive them. Understand that material and energy transformations can be quantified as they cycle through reservoirs.
5-6	L6	Using several simple abstract science concepts, explains that throughout the dynamic inter-relationships in reservoirs materials are conserved. Understand that complex models can be used to explain how changes in a reservoir can affect the properties of other reservoirs.
1-4	L5	How the properties of Earth materials depend on their chemical and physical composition, using several simple abstract scientific concepts. Understand and use simple models to explain the interaction between two or more reservoirs.
	ne	Gives response but does not provide supporting explanation, or gives no response.

Question 6b (Outcome 4 aspects 1 and 2)

9-10	L8	• Critically evaluates their use of principles/theories of sustainable management of resources to interpret and explain balance, cycles and equilibrium in systems as a whole in relation to enhancing quality of life and in relation to each other. • Critically apply theoretical frameworks to critically and ethically evaluate global decisions made about practices that affect economic, social and environmental conditions and make alternative suggestions in relation to each other.
7-8	L7	• Can conceptualise at a level extending beyond what has been dealt with in the actual teaching. • Can generalise to a new area, reflects and apply theories to explain the interrelationship between Earth resources and quality of life. • Can conceptualise at a level extending beyond what has been dealt with in the actual teaching. • Demonstrate a willingness to rework their own understanding of earth and environmental science as a result of ethically evaluating regional decisions about practices that affect social, environmental and economic management.
5-6	L6	• Explains the interrelationship between Earth resources and quality of life, using several simple abstract science concepts and the relationships between them • Explain and apply an understanding of earth and environmental science to make decisions about practices that affect social, environmental and economic management, and evaluate those decisions, using several simple abstract science concepts and the relationships between them.
3-4	L5	• Explains the interrelationship between Earth resources and quality of life, using several simple abstract scientific concepts. • Explain and assess reasons for differing opinions in sustainable practice and how these affect social, environmental and economic management, using several simple abstract scientific concepts.
1-2	L4	• Explains the interrelationship between Earth resources and quality of life that have been experienced or reported, in terms of a non-observable property or simple abstract science concept. • Explains, recognise and suggest reasons for differing opinions in sustainable practice and how these inform and influence social, environmental and economic management that have been experienced or reported, in terms of a non-observable property or simple abstract science concept.
	ne	Gives response but does not provide supporting explanation, or gives no response.

Question 7 (Outcome 3 aspects 1 and 2 and Outcome 1, aspect 4))
Outcome 3

7-8	L7	Can conceptualise at a level extending beyond what has been dealt with in the actual teaching, using an understanding of models and concepts to explain how interactions in Earth Systems cause environmental change. Understand that complex theories can be used to explain the effect of regional processes and events on global environmental changes over time and spatial scales.
5-6	L6	Explains and applies complex models to explain how interactions in Earth processes cause environmental change, using several simple abstract science concepts and the relationships between them. Uses complex models to explain the extent to which different processes and events affect regional changes and present evidence to justify this over time and spatial scales, using several simple abstract science concepts and the relationships between them.
3-4	L5	Explains that the interactions between Earth processes and environmental change can be explained using simple models, and several simple abstract scientific concepts. Explains how processes and events in local environments affect regional environments over time, using several simple abstract scientific concepts
1-2	L4	Explains and describes the Earth processes that cause changes in our environment, that have been experienced or reported, in terms of a non-observable property or simple abstract science concept. Explains that changes in their local environment occur over time and are identifiable, that have been experienced or reported, in terms of a non-observable property or simple abstract science concept understand that changes in their local environment occur over time and are identifiable.
	ne	Answers incorrectly or gives no response.

Outcome 1

4	L7	Evaluates quantitatively material and energy transformations through reservoirs from macroscopic to microscopic levels using appropriate scientific terminology and abstract conceptual models to explain, interpret and make predictions about interactions between energy and matter in physical phenomena.
3	L6	Discusses the properties, using several simple abstract science concepts and explains the relationships between them, then draws conclusions which are consistent with which rocks are found in each layer. Scientifically relates it to the question and critically evaluates the data.
2	L5	Explains phenomena, or interprets reports about phenomena, using several simple abstract scientific concepts.
1	L4	Explains interactions, processes or effects that have been experienced or reported, in terms of a non-observable property or simple abstract science concept.
	ne	Answers incorrectly or gives no response.

Question 8 (Outcome 1, aspects 1 and 4)

9-10	L8	Critically evaluate judgements about the accuracy and precision of measurement in quantitative and qualitative investigations; and design or modify technology to enhance the original experiment.
7-8	L7	Use reference material to identify and understand an authentic problem for investigation; formulate questions or hypotheses; and plan investigations for different aspects of the problem to produce precise data.
5-6	L6	Choose investigation techniques that enhance the safety, accuracy and specificity of the investigation; and ensure the collection of reliable data. Discusses the properties, using several simple abstract science concepts and explains the relationships between them, then draws conclusions which are consistent with which rocks are found in each layer. Scientifically relates it to the question and critically evaluates the data.
3-4	L5	Propose a problem to investigate; plan an experiment in which several variables are controlled; and select appropriate tools for data collection. Explains phenomena, or interprets reports about phenomena, using several simple abstract scientific concepts.
1-2	L4	Identify a question to investigate; plan an experiment in which at least one variable is controlled; and choose data collection procedures and techniques. Explains interactions, processes or effects that have been experienced or reported, in terms of a non-observable property or simple abstract science concept.
	ne	Answers incorrectly or gives no response.

Section 2

Question 9 (Outcome 2, aspects 1, 2 and 4 and Outcome 1, aspect 4)

Using Volcano as geohazard example

Outcome 2

13-15	L8	Plate-tectonics and boundaries, patterns of volcanoes and eruption regularity, Rock cycle-recycling of matter. Isostacy/equilibrium of material and seismology. Understand and critically analyse contemporary theories to explain dynamic Earth interactions.
10-12	L7	Chosen geohazard, given info of geology, and processes at work on the local level e.g. magma rise, limited discussion of monitoring-how often they occur, impact on local or global. Discusses/diagrams rock cycle transformations for eruption to occur more about metamorphic processes etc. Adds quantitative details of all. Discusses lava viscosity and how this relates to extent of flow (rate and speed), ash and gases emitted. Atmospheric transmission/pollution and consequences of these materials. Adds quantitative details of all. Earthquake strength-seismology, interpreting seismographs for epicentres Understand that material and energy transformations can be quantified as they cycle through reservoirs.
7-9	L6	Chosen geohazard, given info of geology, and processes at work on the local level e.g. magma rise, limited discussion of monitoring-how often they occur, impact on local or global. Discusses/diagrams rock cycle transformations for eruption to occur more about metamorphic processes etc. Discusses lava viscosity and how this relates to extent of flow (rate and speed), ash and gases emitted. Atmospheric transmission/pollution and consequences of these materials. Understand that complex models can be used to explain how changes in a reservoir can affect the properties of other reservoirs.
4-6	L5	Chosen geohazard, given info of geology, and processes at work on the local level e.g. magma rise, limited discussion of monitoring-how often they occur, impact on local or global. Discusses/diagrams rock cycle transformations for eruption to occur. Discusses lava viscosity and how this relates to extent of flow (rate and speed), ash and gases emitted. Understand and use simple models to explain the interaction between two or more reservoirs.
1-3	L4	Chosen geohazard, given limited info of geology, and processes at work on the local level, e.g. magma rise, limited discussion of monitoring-how often they occur, impact on local or global Understand that change occurs as part of a cyclic process resulting in an interaction between two or more reservoirs.
	ne	Implausible response or no response given.

Outcome 4

5	L8	Use precise scientific and technical terminology to synthesise information from a range of sources to construct scientifically complex ideas in a variety of forms; and present it to a professional audience.
4	L7	Select and use abstract conceptual models to explain, interpret and communicate their findings and predictions to an informed audience.
3	L6	Use appropriate scientific terminology to describe findings and explain abstract concepts and principles to an audience.
2	L5	Use scientific terminology to communicate findings to a select audience.
1	L4	Use scientific terms to communicate findings to an audience.
	ne	Implausible response or no response given.

Question 10 (Outcome 3, aspects 1, 2 and 3 and Outcome 1, aspect 4)

Outcome 3

13-15	L8	Understand that unifying theories can be used to critically evaluate predictions about interactions in Earth Systems causing environmental change. Understand that unifying theories can build an holistic understanding of the Earth as a dynamic system over time and spatial scales. Understand unifying theories which explain present environmental change, apply these when interpreting past environments and critically analyse and evaluate environmental solutions.
10-12	L7	Understand complex theories to explain how interactions in Earth Systems cause environmental change. Understand that complex theories can be used to explain the effect of regional processes and events on global environmental changes over time and spatial scales Understand and evaluate complex theories and others' predictions about future environmental changes in terms of their consistency with the evidence from past environments.
7-9	L6	Understand and apply complex models to explain how interactions in Earth processes cause environmental change. Understand complex models to explain the extent to which different processes and events affect regional changes and present evidence to justify this over time and spatial scales. Understand that evidence from the past can inform complex models to make predictions about the possible short-term future of particular environments.
4-6	L5	Understand that the interactions between Earth processes and environmental change can be explained using simple models. Understand how processes and events in local environments affect regional environments over time. Understand that simple models can be used to predict future environmental change based on past and present evidence.
1-3	L4	Understand and describe the Earth processes that cause changes in our environment. Understand that changes in their local environment occur over time and are identifiable. Understand present and past Earth processes and environments in their local surroundings.
	ne	No suitable response given.

Outcome 4

5	L8	Use precise scientific and technical terminology to synthesise information from a range of sources to construct scientifically complex ideas in a variety of forms; and present it to a professional audience.
4	L7	Select and use abstract conceptual models to explain, interpret and communicate their findings and predictions to an informed audience.
3	L6	Use appropriate scientific terminology to describe findings and explain abstract concepts and principles to an audience
2	L5	Use scientific terminology to communicate findings to a select audience
1	L4	Use scientific terms to communicate findings to an audience.
	ne	No suitable response given.