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2016 HSC Earth and Environmental Science Marking Guidelines

IMPORTANT:
This resource was developed to support a previous version of the syllabus.
It may contain content that differs from the current syllabus.

Section I, Part A

Multiple-choice Answer Key

Question	Answer
1	A
2	D
3	C
4	D
5	B
6	A
7	B
8	D
9	A
10	A
11	D
12	B
13	A
14	D
15	B
16	D
17	C
18	A
19	B
20	C

Section I, Part B

Question 21 (a)

Criteria	Marks
• Gives details of the formation of both intraplate and plate boundary earthquakes	4
• Gives details of the formation of either intraplate or plate boundary earthquakes and gives some information about the other	3
• Gives details on the formation of either intraplate or plate margin earthquakes OR • Gives some information about intraplate and plate margin earthquakes	2
• Gives some relevant information	1

Sample answer:

In intraplate earthquakes, as a continental plate moves over hotter or colder asthenosphere, the stress regime changes as the plate is stressed or compressed. If the stress builds up too much, rock strata may fracture and move across fault planes. Energy is released as earthquake waves.

Plate boundary earthquakes can occur when the stress regime builds up as one plate is subducted under another. Again the rocks move rapidly across the fault planes and energy is released as earthquake waves. Because stress regimes are higher at plate boundaries, more earthquakes occur.

Question 21 (b)

Criteria	Marks
• Gives details of surface waves and gives reasons why damage to buildings occurs	4
• Sketches in general terms surface waves and refers to damage to buildings	3
• Sketches in general terms earthquake waves and/or damage to buildings	2
• Gives some relevant information	1

Sample answer:

During an earthquake, surface waves pass through the ground and then through structures, such as buildings on the ground. If a building vibrates with the same frequency as the surface wave, then the building resonates with the surface wave and can be damaged if the resonance is great. Buildings that do not resonate with the surface wave are not damaged. Surface waves cause liquefaction in sand or soil. Buildings on sand can sink into the liquefied sand and be damaged. Buildings on solid rock are not affected by liquefaction.

Question 22 (a)

Criteria	Marks
• Details one method for predicting volcanic eruptions	2
• Gives some relevant information	1

Sample answer:

A tiltmeter is a very sensitive instrument that measures changes in the shape or size of a volcano caused by the build-up of gases or magma within the dome or chamber. These measured changes can be used to predict eruptions.

Question 22 (b)

Criteria	Marks
• Gives TWO reasons for the continued research into volcanic eruptions	2
• Gives some relevant information	1

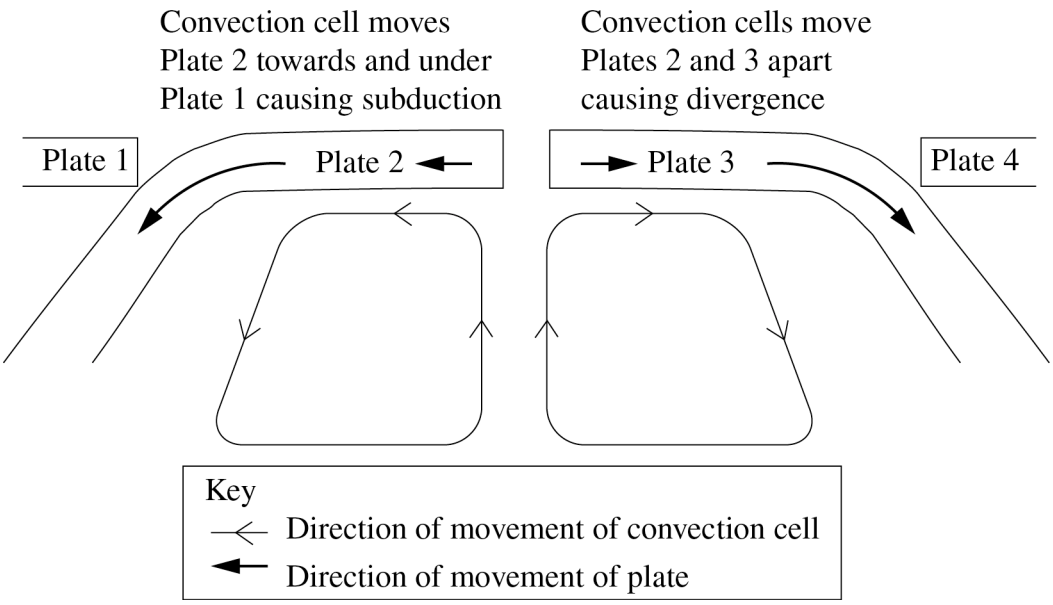
Sample answer:

Research into volcanic eruptions should continue to provide a better understanding of pending eruptions. If an explosive eruption could be accurately predicted, aircraft movements could be changed to minimise damage from ash clouds. Also, people living on the slopes of volcanoes could be moved before the eruption, thus minimising loss of life.

Question 23

Criteria	Marks
• Draws a fully labelled diagram that relates convection cell/s to divergence and convergence at plate boundaries	4
• Draws a diagram with some labels that show convection cell/s and plate boundaries	3
• Draws a diagram	2
• Gives some relevant information	1

Sample answer:



Question 24 (a)

Criteria	Marks
• Gives features of the evidence in general terms	1

Answers could include:

Students can outline the features of such evidence as

- Simulations
- Models
- Photographs
- Changes in evolutionary trends
- Diversification of fossil types.

Question 24 (b)

Criteria	Marks
• Identifies criteria for validity • Links criteria to the evidence • Makes a clear judgement as to the validity of the evidence	3
• Identifies at least one criterion for validity • Links to the evidence or makes a judgement	2
• Gives some relevant information	1

Sample answer:

Evidence such as simulations is valid because it is best able to

- make use of modern technology
- represent current scientific evidence
- be reviewed by experts.

Question 25

Criteria	Marks
• Details the relationship between BIFs and oxygen in oceans/lakes • Details the formation of oxygen by early aquatic photosynthetic organisms • Relates BIF formation to early life	4
• Gives the relationship between BIFs and oxygen in oceans/lakes • Outlines the formation of oxygen by early aquatic photosynthetic organisms • Links BIF formation to early life	3
• Gives some information about BIFs and oxygen or early life	2
• Gives some relevant information	1

Sample answer:

BIFs result from the oxidation of iron which then settles to form the distinct bands. The oxygen results from early aquatic life that produced the oxygen as a waste product of photosynthesis. The BIFs are thus a trace fossil as the presence of oxygen and the resulting formations are the result of photosynthetic life.

Question 26 (a)

Criteria	Marks
• Distinguishes between diversity and numbers	2
• Outlines either diversity and/or numbers	1

Sample answer:

Diversity of fossils = the number of different fossil species.
Number of fossils = the number of individual fossils.

Question 26 (b) (i)

Criteria	Marks
• Provides reasons in favour of using the source • Refers to the source	2
• Provides some relevant information	1

Sample answer:

This would be a good source to plan such an investigation. It provides information regarding the location of possible sites and significantly it identifies key hazards that should be considered for personal safety.

Question 26 (b) (ii)

Criteria	Marks
• Provides features of the depositional environment of the Triassic shales	2
• Provides some relevant information	1

Sample answer:

The Triassic rocks were deposited in a relatively calm, shallow marine estuarine or freshwater environment.

Question 26 (b) (iii)

Criteria	Marks
• Provides at least two pieces of information from the source to support their answer	2
• Provides some relevant information	1

Sample answer:

The fish and amphibians identified in the source show the environment was a shallow lake or ocean and the deposition of clay (which changed to shale) indicates a low energy or calm environment. Plant fossils indicate vegetation on the shoreline.

Question 27

Criteria	Marks
• Identifies a cause of soil erosion • Provides a program/strategy to overcome erosion • Makes a judgement of the success of the program • Links the program and judgement to the cause of soil erosion	3
• Identifies a cause of soil erosion • Provides a program/strategy to overcome erosion	2
• Some relevant information is given	1

Sample answer:

Cause of soil erosion	Land clearing
Outline of program/strategy used to overcome soil erosion	Planting rows of native trees around the perimeter of the paddock as windbreaks.
Evaluation of the program/strategy	The trees provide an increasingly successful windbreak as they grow taller. Additionally they help to prevent high soil salinity from developing, as the roots grow deeper. The topsoil accumulates over time. The program is successful and has been extended.

Question 28

Criteria	Marks
• Identifies the common areas of land clearing, irrigation and salinity • Details components of the three maps • Draws out and relates to the implications for salinity • Uses information from the maps	4
• Identifies the common areas of land clearing, irrigation and salinity • Generally relates these to salinity • Uses information from the maps	3
• Sketches in general terms the areas of land clearing and irrigation • Generally relates these to salinity OR suggests an implication	2
• Provides some relevant information	1

Sample answer:

The majority of the land and rivers at risk of high salinity have been subjected to land clearing and irrigation.

However, if the land clearing regions on the map alone are compared to salinity risk, there are cleared areas that do not have a salinity risk problem, such as the south coast of Victoria and central southern Queensland. If irrigation alone is compared to salinity risk, then the map shows relatively large areas of irrigation on the northern and central coast of Western Australia and areas of Tasmania that are not at risk of salinity.

Conversely, there are areas of soil and water salinity risk in northern parts of the Northern Territory that are neither cleared nor irrigated.

Overall, the salinity risk and poor water quality correlates with most of the areas of cleared and irrigated land. This suggests that both practices used together could contribute to salinity risk.

Question 29

Criteria	Marks
• Names a banned pesticide • Details the impact on non-target species • Details impact on human health • Gives reasons for the banning of the pesticide	4
• Names a banned pesticide • Details the impact on non-target species or human health OR sketches in general terms the impact on non-target species and human health • Gives a reason for the banning of the pesticide	3
• Sketches in general terms the impact of pesticides on non-target species or human health • Gives a reason	2
• Gives some relevant information	1

Sample answer:

A pesticide such as DDT is non-selective and impacts on a broad range of species, such as the many insect species. It is used widely to control pest species in agriculture.

Insects affected may be both beneficial, like bees that are responsible for the pollination of many flowering plants, and harmful like grasshoppers that feed on crops. Bees are non-target species whereas grasshoppers are target species.

Residual pesticides and the effect on non-target species can impact on human health as the residual pesticides can be accumulated in the food chains and, in some cases, toxic levels in humans can be reached.

Question 30 (a)

Criteria	Marks
• Gives features of both a local and a global strategy to reduce methane emissions • Uses information from the graph	3
• Sketches in general terms a local and a global strategy to reduce methane emissions OR gives features of a local or global strategy to reduce methane emissions • Uses information from the graph	2
• Provides some relevant information	1

Sample answer:

One local strategy would be for all landfills to collect methane emissions to use as biofuel to generate their own electricity.

One global strategy would be to reduce the use of fossil fuels as sources of energy, and so reduce the extent of their mining. They could be replaced by renewable alternative fuels that do not produce methane.

Question 30 (b)

Criteria	Marks
• Details a reason for not targeting wetlands	2
• Provides some relevant information	1

Sample answer:

Wetlands are an important ecological resource. If humans intervened by reducing these areas, there would be detrimental implications for the natural processes occurring there. For example, there would be a reduction in the number of breeding sites for many bird species.

Question 31

Criteria	Marks
• Demonstrates a depth or breadth of knowledge and understanding of the use of models in Earth and Environmental Science • Clearly links use of models to explaining natural and human processes • Uses the source and one other example • Makes a clear judgement, using supporting arguments, about the value of using models in Earth and Environmental Science • Demonstrates a coherent and logical progression of thought and indicates a high level of the use of scientific principles, ideas and terminology	7
• Has a knowledge of the use of models in Earth and Environmental Science • Links knowledge of models to explaining natural and human processes • Uses the source and one other example • Makes a judgement as to the value of using models in Earth and Environmental Science • Uses appropriate terminology and progression of thought	5–6
• Recalls relevant knowledge of the use of models in Earth and Environmental Science • Attempts to link knowledge of models to explaining natural and human processes • Uses examples • Uses suitable terminology and/or progression of thought	3–4
• Provides some relevant information	1–2

Sample answer:

Models are methods that are used to simplify, usually graphically or visually, complex phenomena or processes. Data are collected and patterns within the data are used to formulate or construct a model. Models are tested against additional data and if validated they can be used to explain or predict other phenomena or processes. If a model is not validated by additional data, modifications are made to the model and it is retested.

The model shown allows a comparison to be made between the impact of natural and human activities on fauna that lived in Australia or North America. From the model there is a suggestion that human activity is more significant than climate change as the cause of the extinction of fauna if they co-exist for a long period, as in Australia. On the other hand, the model suggests that not only was the extinction of fauna in North America caused by climate change but human occupation of North America also affected the fauna. This model oversimplifies the cause of fauna extinction in Australia because recent data suggests that causes such as climate change may be as important as human activities. Thus the model needs to be reformed or a new model developed.

Geologists have developed the convection cell model to explain the natural movement of lithospheric plates. In this model upwelling hot fluids rise through the mantle. The currents move horizontally and friction drags the crustal plates in the direction of the currents. New data shows the convection cell model has limitations and newer models are being developed.

Other models have been developed to explain the depletion of natural resources, evolutionary events, climate change and global warming.

Models are only as good as the data from which they are formulated and as new data become available models have to be refined or modified to fit the data. Models are not only useful tools to interpret large volumes of data but, as new technologies provide more complex and larger volumes of data, models must be used to understand the complexities of the natural and human impacts on Earth.

Section II

Question 32 (a)

Criteria	Marks
• Gives details of TWO impacts of introduced species on the Australian environment	3
• Sketches in general terms TWO impacts of introduced species on the Australian environment	2
• Provides some relevant information	1

Sample answer:

Introduced species, if successful, are well-adapted to the abiotic conditions of their environment. As a result they breed in large numbers and may have an adverse effect on the stability of their surroundings. For example, rabbits breed in large numbers and deplete the grass and strip the bark from young trees and shrubs. Another impact is that introduced species out-compete native species for the same resources, such as food and shelter.

Question 32 (b)

Criteria	Marks
• Gives detailed features of high reproductive capacity and well-developed dispersal mechanisms. • Relates these to the success of a named introduced species	4
• Sketches in general terms the features of high reproductive capacity and well-developed dispersal mechanisms • Makes a link to a named introduced species	3
• Sketches in general terms the features of high reproductive capacity OR well-developed dispersal mechanisms • Makes a link to introduced species	2
• Provides some relevant information	1

Sample answer:

Cane toads have a high reproduction rate. They lay large numbers of eggs which have a short hatching time providing water is available. Many tadpoles survive as they are opportunistic feeders and have a fast maturing process with a short reproductive cycle. This allows their numbers to increase quickly. They also have well-developed dispersal mechanisms, often hitching a ride in cargo or in the undercarriage of transport vehicles over large distances. This helps them to disperse across inhospitable terrain and spread more quickly than other introduced or native amphibian species.

Question 32 (c) (i)

Criteria	Marks
• Gives features of TWO trends	2
• Gives one trend	1

Sample answer:

Two trends in the graph shown are:

- There are natural fluctuations in rabbit populations before and after the introduction of Biological Control I – from 1927 until 1955, and again from 1963 until 1995
- There is a sharp decline in rabbit numbers after both biological controls were introduced, in 1955 and 1995.

Question 32 (c) (ii)

Criteria	Marks
• Demonstrates an understanding of biological controls as used for pest management • Relates the effectiveness of the biological controls to rabbits • Makes suggestions for future sustainability AND economic loss • Uses data from the graph	4
• Sketches in general terms the nature of biological controls • Makes some link to rabbits • Makes a judgement on future sustainability OR economic loss • Uses data from the graph	3
• Outlines the use of biological controls • Makes some link to rabbits	2
• Provides some relevant information	1

Sample answer:

The rabbit population dropped rapidly to well below the mean when each of the biological controls was introduced in 1955 and 1995. Thus the data show that biological controls are a very effective method of reducing rabbit populations. Rabbits can rapidly make an ecosystem unsustainable because of the amount of food they eat and their reproductive rates. The graph shows that the economic loss is a function of rabbit population – high losses with large populations and vice versa. Thus biological controls remain an effective future strategy. Not only will ecosystems be more sustainable when biological controls are used but economic losses will also be reduced.

Question 32 (d) (i)

Criteria	Marks
• Names an ecosystem • Details the type of data to be collected to identify, classify and account for any introduced species present • Details the equipment and materials to be used • Details the method of recording data	4
• Names an ecosystem • Outlines the type of data to be collected to identify, classify and account for any introduced species present • Outlines the equipment and materials to be used • Outlines the method of recording data	3
• Provides some information about the data to be collected • Gives some information about the equipment and materials to be used OR the method of recording data	2
• Provides some relevant information	1

Sample answer:

A freshwater lake in the Penrith Lakes area was chosen as it had ongoing problems with infestations of water weeds such as *Salvinia* and Alligator Weed.

The type of data to collect is:
- identification and measurements of the abiotic features, such as temperature, flow rate, pH and salinity of the water
- identification of as many non-indigenous plant and animal species as can be found
- any evidence of human influence/intervention.

Make a list of the equipment and materials needed.

For the abiotic features these would include:
- a thermometer
- a stopwatch and measuring tape for flow rate
- a turbidity tube
- Universal Indicator paper
- silver nitrate solution in dropper bottles
- sample vials.

For the biotic features: a net to capture invertebrates, small fish, amphibians and plants, an identification chart reference, a camera.

The methods of recording data would be tables for the abiotic features and the organisms found; photographs, a distribution transect or surface map for *Salvinia* growth.

Question 32 (d) (ii)

Criteria	Marks
• Sketches in general terms the Bradley method	2
• Gives some relevant information	1

Sample answer:

The Bradley method of rehabilitating an area infested with non-indigenous species has the following main features:

1. Work outwards from least infested bush to the most infested bush until all non-native plants have been removed. This allows time for native species to move out and resettle.
2. Remove any regrowth of the non-indigenous species.
3. Work is often done by hand so as not to harm native species.

Question 32 (e)

Criteria	Marks
• Demonstrates a breadth or depth of knowledge and understanding of introduced species over time, using examples • Clearly links knowledge of introduced species to society's changing attitudes • Makes a clear judgement, using supporting arguments, as to how society's attitudes have changed • Demonstrates a coherent and logical progression of thought and indicates a high level use of scientific principles, ideas and terminology	6
• Has a knowledge of introduced species over time, using examples • Links knowledge of introduced species to society's changing attitudes • Makes a judgement as to how society's attitudes have changed • Uses appropriate terminology and/or progression of thought	4–5
• Recalls relevant knowledge of introduced species and/or attempts to make a judgement as to how society's attitudes have changed • Uses suitable terminology and/or progression of thought • Gives an example	2–3
• Provides some relevant information	1

Sample answer:

Australian attitudes to introduced species have changed since the late 18th and 19th centuries. The early settlers, the military and the convicts were homesick as Australia was a harsh environment compared to the home countries. So, to help them settle in, they introduced many British plants and animals.

With modern cities there was an expansion of British trees and flowers into the suburbs; native plants were removed to make way for the British plants and flowers. Transport became faster and more widespread, but was responsible for the importation of many non-native species. These include the Pacific oyster from ballast water.

Another source of introduction came from the agriculturalists who needed to control pests in their crops. So, with the replacement plants came the insects that pollinate them. Biological controls were introduced deliberately as a means of selective destruction of introduced pests. These controls include the Cane Toad and the Mosquito Fish, both unsuccessful in controlling their target prey.

Today, research is focused on importing an array of biological controls as these target their prey and, when the numbers of the introduced species decrease, the introduced biological control's numbers also decrease as their food supply runs out. This, together with quarantine and border patrol, are the three most effective strategies for eliminating earlier introduced species. The extent to which Australian society's attitude has changed from actively encouraging introduced species to investing money for research to control introduced species is encouraging for the future of the country.

Question 33 (a)

Criteria	Marks
• Gives details of TWO methods that can be used to conserve energy in buildings	3
• Sketches in general terms TWO methods that can be used to conserve energy in buildings	2
• Gives some relevant information	1

Sample answer:

Insulation of walls and roof cavities reduces the energy input in summer, thus keeping the building cooler. This insulation also minimises energy loss out of the building in winter, thus keeping the building warmer.

The use of double-glazed windows coated with a reflective surface reduces heat loss from the building in winter and minimises heat input during summer.

Question 33 (b)

Criteria	Marks
• Has a detailed understanding of an exploration program that includes drilling suitable for coal exploration • Details reasons for a drilling program	4
• Sketches in general terms features of an exploration program that includes drilling suitable for coal exploration • Outlines a reason for a drilling program	3
• Has some understanding of an exploration program that includes drilling suitable for coal exploration • Gives a reason for the program	2
• Gives some relevant information	1

Sample answer:

Surface mapping could be undertaken to determine the geology and surface features that might have an impact on the mining potential of the coal. For example, it is probable that open pit mining would be used, initially at least, and thus the nature of the overburden to be removed could be determined. In addition potential drill sites could be identified.

A drilling program, using information gained during surface mapping, provides detailed information on the subsurface geology. The extent and variation in seam thickness could be determined. From this information it could be seen if the layers thicken or amalgamate. Drilling gives more detailed information than geophysical surveys which could be used.

Question 33 (c) (i)

Criteria	Marks
• Gives features of two trends	2
• Gives features of one trend	1

Sample answer:

Oil consumption has generally increased from 700 thousand barrels per day in 1990 to more than 1000 thousand barrels per day in 2012 with minor variations in some years.

Coal consumption increased from 100 million short tons in 1990 to a maximum of 150 million short tons in 2009 and then decreased slightly after that, until it increased again after 2011.

Question 33 (c) (ii)

Criteria	Marks
• Demonstrates an understanding of fossil fuel resources • Relates sustainability to the rate of use of fossil fuels • Makes suggestions about future production and consumption • Uses data from the graph	4
• Provides information about fossil fuel resources • Makes predictions about future production or consumption • Uses data from the graph	3
• Provides information about fossil fuel resources and/or information about production or consumption	2
• Provides some relevant information	1

Sample answer:

Fossil fuel resources are finite and thus must eventually be mined out. The graph shows oil consumption has been steadily increasing from 700 000 barrels per day in 1990 to more than 1 000 000 in 2012 and this will continue to increase. This consumption rate cannot continue forever. Oil production will start to decrease sooner than would have been the prediction in 1990 if production rates continue to increase following the present trend. Coal consumption decreased markedly from 2009 to 2012 and will continue to decrease and thus the resources will last longer than may have been predicted in 2009. Oil production has decreased from a peak in 2000 whereas coal production has increased steadily. Thus coal production can continue much longer than may have been predicted in 1990.

Question 33 (d) (i)

Criteria	Marks
• Details the type of data to be collected to test the energy efficiency of alternative energy sources • Details the equipment and materials to be used • Details the method of recording data	4
• Outlines the type of data to be collected to test the energy efficiency of alternative energy sources • Outlines the equipment and materials to be used • Outlines the method of recording data	3
• Provides some information about the data to be collected • Gives some information about the equipment and materials to be used OR the method of recording data	2
• Provides some relevant information	1

Sample answer:

To test for the energy efficiency of alternative energy sources, energy sources must be combusted and the energy produced measured.

The following data has to be collected:
- name of energy source
- mass of each energy source
- temperature of cold water
- temperature of hot water.

The equipment needed is:
- Bunsen burner
- four beakers of water
- four energy sources
- four thermometers.

The results would be recorded in table form with the following columns:
- name of energy source
- mass of energy source
- temperature of cold water
- temperature of heated water
- temperature difference.

Question 33 (d) (ii)

Criteria	Marks
• Gives information about coal as a raw material for industry • Gives examples	2
• Gives some relevant information	1

Sample answer:

Coal is a raw material for many commodities such as coke dyes, drugs, disinfectants, acetylene and synthetic fibres. When coal is heated in the absence of air, volatiles are removed leaving a carbon-rich product, coke, that is a more efficient energy source. Dyes and drugs are formed from chemicals that are produced from coal.

Question 33 (e)

Criteria	Marks
• Demonstrates a breadth or depth of knowledge and understanding of alternative energy sources over time, using examples • Clearly links knowledge of alternative energy sources to society's changing attitudes • Makes a clear judgement, using supporting arguments, as to how society's attitudes have changed • Demonstrates a coherent and logical progression of thought and indicates a high level use of scientific principles, ideas and terminology	6
• Has a knowledge of alternative energy sources over time, using examples • Links knowledge of alternative energy sources to society's changing attitude • Makes a judgement as to how society's attitudes have changed • Uses appropriate terminology and/or progression of thought	4–5
• Recalls relevant knowledge of alternative energy sources and/or attempts to make a judgement as to how society's attitudes have changed • Uses suitable terminology and/or progression of thought • Gives an example	2–3
• Provides some relevant information	1

Sample answer:

In the 20th century Australia and the world relied on fossil fuels such as coal and crude oil as energy sources for electricity generation and transport. Fossil fuels were cheap, generally easy to obtain and reserves were large. Society was in favour of not only using fossil fuels but increasing the use of them. Little effort was made to use alternative energy sources.

Once the impact of burning fossil fuels became apparent, society's attitudes changed. More emphasis was placed on finding alternative sources of energy. Fifty years ago, few houses had solar heating or solar electricity generation. Once society realised that it was a clean energy source and not much more expensive than fossil fuel generation, society's attitude changed from one of not using solar generation to one of favouring its use.

Attitudes to other alternative energy sources such as wind, tidal, nuclear and synthetic fuels also changed. More and more people could see the benefits of these energy sources, particularly the low impact on the environment. Initially alternative energy sources were seen as small scale sources. Now society sees these sources as being able to be scaled up to source energy for large installations.

Overall society sees a greater need for alternative energy sources and less reliance on fossil fuels. The only alternative energy source that is not favoured by many Australians is nuclear energy. It is still seen to have many problems.

Question 34 (a)

Criteria	Marks
• Details the features of one model for mineralisation in an island arc terrane	3
• Sketches in general terms the mineralisation in an island arc terrane	2
• Provides some relevant information	1

Sample answer:

The hydrothermal model explains mineralisation in an island arc terrane. The model is based on data collected from many deposits and states that the hot fluids associated with volcanic activity circulate through country rocks dissolving out metals such as gold and silver. The hot fluids rise and where the temperature, oxidation potential or pressure changes, the metals (gold and silver) are precipitated along with other minerals such as sulfides.

Question 34 (b)

Criteria	Marks
• Shows a detailed understanding of an Environmental Impact Statement • Details issues that should be addressed in the EIS for this mine • Relates issues to this mining operation	4
• Sketches in general terms the features of an Environmental Impact Statement • Outlines issues that should be addressed in the EIS for this mine • Relates at least one issue to this mining operation	3
• Shows some understanding of an Environmental Impact Statement • Outlines an issue that should be addressed in the EIS or relates one issue to mining operations	2
• Provides some relevant information	1

Sample answer:

An Environmental Impact Statement for this mine should have provided a blueprint for the actions that had to be undertaken during mining and after mine closure to minimise the impacts of the operations on the environment.

Issues that should have been addressed in an EIS include:

- A cultural heritage survey to protect Aboriginal sacred sites
- An inventory of flora and fauna so that the impact on fauna can be minimised during mining and the same species of plants can be planted after mining ceases. This is an open cut mine. Thus the EIS should have addressed where soil should have been placed until it could be reused, where overburden waste should have been dumped and also where tailings should have been dumped.

The local community should have been consulted to inform them of the scope and scale of the operations, how hazards were to be reduced during mining and to inform them of the rehabilitation program after mining. For example, the photograph shows contaminated water. The community should have been informed of the dangers of this material and how it should have been treated.

Question 34 (c) (i)

Criteria	Marks
• Gives features of TWO trends	2
• Gives features of one trend	1

Sample answer:

The general trend in world copper production is a gradual increase from 1900 to about 1950, and then a more rapid increase to 2010, punctuated by minor fluctuations throughout.

The general trend in copper price is for a general decrease from 1900 to 2010 but with relatively large cyclic fluctuations punctuated by quite large rises and falls throughout.

Question 34 (c) (ii)

Criteria	Marks
• Demonstrates an understanding of factors that have an impact on metal production • Relates feasibility to the rate of mining metals • Suggests what will happen to metal mining in the future • Uses data from the graph	4
• Gives information about factors that have an impact on metal production • Makes a prediction • Uses data from the graph	3
• Gives information about metal production and/or makes a prediction about metal mining	2
• Gives some relevant information	1

Sample answer:

All metals, including copper, have finite resources and consequently will eventually be mined out. The graph shows that copper production has been rapidly accelerating from approximately 2 million metric tons in 1950 to 16 million metric tons in 2010. This production rate is untenable in the future. The graph shows that the price of copper fluctuates and has little impact on production. Thus factors other than price probably have an impact on copper production. At a specific mine, infrastructure costs, grade of the deposit and deposit size probably have an impact on copper production. In the long term, metal production will decrease because of the finite resources.

Question 34 (d) (i)

Criteria	Marks
• Details the type of data to be collected to test for the presence of ore minerals • Details the equipment and materials to be used • Details the method of recording data	4
• Outlines the type of data to be collected to test for the presence of ore minerals • Outlines the equipment and materials to be used • Outlines the method of recording data	3
• Provides some information about the data to be collected • Gives some information about the equipment and materials to be used OR the method of recording data	2
• Provides some relevant information	1

Sample answer:

To test for the presence of ore minerals in rocks the density of the rock needs to be determined. Ores have much higher densities than non-ore rocks.

The following data have to be collected:
- name of several ores
- weight of ores in air
- weight of ores in water.

The equipment needed would be:
- a balance
- beaker of water
- string.

The results would be recorded in a table with the following columns:
- name of several ores
- weight of ores in air
- weight of ores in water
- density.

Question 34 (d) (ii)

Criteria	Marks
• Sketches in general terms how drilling is used to determine both the size and grade of a deposit	2
• Provides some relevant information	1

Sample answer:

While other exploration methods can be used to find mineral deposits, drilling must be used to determine both the size and grade of a deposit. A drilling program of several to many holes allows many samples of the ore to be assayed for grade. The more holes drilled the more accurately the size of the deposit can be delineated.

Question 34 (e)

Criteria	Marks
• Demonstrates a breadth or depth of knowledge and understanding of exploration methods for mineral deposits over time, using examples • Clearly links knowledge of exploration methods for mineral deposits to society's changing attitudes • Makes a clear judgement, using supporting arguments, as to how society's attitudes have changed • Demonstrates a coherent and logical progression of thought and indicates a high level use of scientific principles, ideas and terminology	6
• Has a knowledge of exploration methods for mineral deposits over time, using examples • Links knowledge of exploration methods for mineral deposits to society's changing attitude • Makes a judgement as to how society's attitudes have changed • Uses appropriate terminology and/or progression of thought	4–5
• Recalls relevant knowledge of exploration methods for mineral deposits and/or attempts to make a judgement as to how society's attitudes have changed • Uses suitable terminology and/or progression of thought • Gives an example	2–3
• Provides some relevant information	1

Sample answer:

Exploration methods have become more dependent on information technology because this allows easier and more reliable prediction of potential deposits and permits larger amounts of data to be assayed more reliably and much faster than older methods. For example, in the middle part of the 20th century, geological maps were drawn by hand whereas in the 21st century, maps are computer drawn. Likewise the limited data that was collected was collated by hand and graphs and other methods of presentation used manual techniques. Today computers can collate vast amounts of data rapidly and not only can the presentation of data be collated into graphs etc, the data can be used to construct models which can then be tested and refined with many iterations. Modelling is becoming a very important tool as mineral deposits deep under the surface can be predicted based on surface information.

Exploration methods have changed dramatically. Federal and State laws have required greater awareness of the environment and indigenous cultures. Magnetic surveys, gravity surveys and geochemical surveys were once carried out on foot. Now planes and helicopters can be used to retrieve more and better quality data. In addition, new technologies are being developed. For example, satellites can use remote sensing techniques to produce geochemical maps that are based on detection limits of parts per million and parts per billion for some elements.

Question 35 (a)

Criteria	Marks
• Gives details of TWO ways in which the oceans influence conditions on the Earth's surface	3
• Sketches in general terms TWO ways in which the oceans influence conditions on the Earth's surface	2
• Provides some relevant information	1

Sample answer:

Ocean currents move heat energy from the equator toward the poles. This influences surface temperatures and weather patterns.

Water temperature influences evaporation and resulting cloud formation. This in turn influences rainfall levels.

Cold currents = low rainfall

Warm currents = high rainfall

Question 35 (b)

Criteria	Marks
• Gives detailed features of how the attenuation of light changes with depth • Relates these to the distribution of marine plants	4
• Sketches in general terms how the attenuation of light changes with depth • Makes a link to the distribution of marine plants	2–3
• Provides some relevant information	1

Sample answer:

The attenuation of light determines the depth to which each wavelength of light can penetrate the water. This in turn has an impact on possible plant habitats as plants are dependent on light for photosynthesis. Violet and blue wavelengths penetrate more deeply than green and red. The depth and thus the wavelength of light absorbed can directly influence the type of algae to be found. For example, green algae are more likely to be found closer to the surface than red algae, which occur at greater depths.

Question 35 (c) (i)

Criteria	Marks
• Gives features of TWO trends in the graph	2
• Gives features of one trend in the graph	1

Sample answer:

As the temperature increases the solubility of the salts also increases.

Potassium nitrate solubility increases more rapidly than either of the chlorides.

Question 35 (c) (ii)

Criteria	Marks
• Demonstrates an understanding of salinity in oceans and small enclosed seas • Relates the solubility of salts to the type of water body • Makes suggestions about the causes of changes in solubility of salts • Uses data from the graph	4
• Sketches in general terms solubility of salts in oceans and small enclosed seas • Makes some link between solubility of salts and the type of water body • Uses data from the graph	3
• Outlines the nature of salt solubility • Makes some link between the type of water body and solubility	2
• Provides some relevant information	1

Sample answer:

The solubility of salts increases from 0°C to 100°C.

From this data there would be little variation in oceans if there is little change in overall temperature.

Small enclosed seas like the Dead Sea would have a higher temperature and thus a higher level of solubility.

High temperature environments like hydrothermal vents would also have higher levels of solubility.

NB: Ocean salinity variations are influenced by other variables than temperature alone, such as volume, composition and rate of evaporation.

Question 35 (d) (i)

Criteria	Marks
• Details the type of data to be collected • Details the equipment and materials to be used • Details the method of recording data	4
• Outlines the type of data to be collected • Outlines the equipment and materials to be used • Outlines the method of recording data	3
• Provides some information about the data to be collected • Gives some information about the equipment and materials to be used OR the method of recording data	2
• Provides some relevant information	1

Sample answer:

To investigate surface area to volume ratio of solids on cooling rate in water:

- collect three appropriate metal shapes (cube, pyramid and sphere) which have been heated to the same temperature
- calculate their surface area to volume ratios
- measure change in temperature of water in which they are placed, over a time.

Equipment:

- metal objects
- water
- heat source
- beakers × 3
- tongs
- data logger – probe (temperature).

Recording data:

- data logger graph showing temperature change over time
- table to compare the results regarding shape of objects
- graph results.

Question 35 (d) (ii)

Criteria	Marks
• Sketches in general terms the characteristics of a deep-sea hydrothermal vent	2
• Gives some relevant information	1

Sample answer:

Seawater penetrates into new ocean crust and becomes heated. It reacts with the crustal rocks and rises to the sea floor. The hot water comes into contact with cold seawater and dissolved minerals precipitate out forming vent tubes described as 'Black smokers'. These unique conditions can give rise to chemosynthetic bacteria that are the producers and the basis of unique deep-sea communities of highly adapted organisms.

Question 35 (e)

Criteria	Marks
• Demonstrates a breadth or depth of knowledge and understanding of ocean resources, using examples • Clearly links knowledge of ocean resources to Australian society's changing attitudes • Shows the extent, using supporting arguments, to which Australian society's attitudes have changed • Demonstrates a coherent and logical progression of thought and indicates a high level use of scientific principles, ideas and terminology	6
• Has a knowledge of ocean resources, using examples • Links knowledge of ocean resources to society's changing attitudes • Shows the extent to which Australian society's attitudes have changed • Uses appropriate terminology and/or progression of thought	4–5
• Recalls relevant knowledge of ocean resources and/or attempts to show the extent to which Australian society's attitudes have changed • Uses suitable terminology and/or progression of thought • Gives an example	2–3
• Provides some relevant information	1

Sample answer:

Australian society's attitude has clearly changed over time regarding the use of the oceans as a resource. Resources that have been exploited include commercial fish and invertebrate species, minerals and chemicals such as sulfur and manganese.

One specific example can be found in the fishing industry where in the past such species as whales were exploited ruthlessly. Today the whales are a feature of the tourism industry and most Australians are opposed to the whale hunting of countries such as Japan.

Another example of changing attitudes can be seen in the public awareness and technological improvements regarding waste disposal into coastal waters. Significant gains have been made to improve the overall quality of the affected beaches and waterways through appropriate legislation.

Australian attitudes have improved significantly and can be expected to develop further in the coming years.

Important laws about the oceans have been introduced and have resulted in changing attitudes.

Positive attitudes:
- increased awareness of ocean environment
- laws regarding waste disposal
- ecotourism
- improved technology for waste disposal
- fishing quotas
- protected reservations.

Negative attitudes:
- over-exploitation
- Japanese whale hunting
- use for waste disposal.

2016 HSC Earth and Environmental Science Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.2.2.2.1	H7
2	1	9.3.2.3.1	H8
3	1	9.4.6.2.3	H7
4	1	9.2.5.2.1	H7
5	1	9.2.4.2.5	H7
6	1	9.3.1.2.2	H7
7	1	9.3.3.2.3, 9.3.3.2.2	H3
8	1	9.3.1.3.1, 9.3.5.2.5	H8
9	1	9.4.6.3.2	H7
10	1	9.4.1.3.1	H7
11	1	9.3.3.2.5	H8
12	1	9.4.6.2.4	H1
13	1	9.2.3.2.1	H7, H8
14	1	9.2.1.2.3	H7
15	1	9.3.5.2.2, 9.3.5.2.4	H8
16	1	9.3.1.2.1	H14, H11.2(c)
17	1	9.4.5.2.1	H10
18	1	9.2.1.2.3	H7, H8, H14.2(a), H14.3(d)
19	1	9.2.3.2.1	H7, H8
20	1	9.4.7.3.1	H7, H11.3(c)

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21 (a)	4	9.2.4.2.4	H7
21 (b)	4	9.2.4.3.3	H7
22 (a)	2	9.2.4.2.2	H7
22 (b)	2	9.2.4.2.6	H7
23	4	9.2.1.2.4	H7, H13.1(b)
24 (a)	1	9.3.3.3.2	H8
24 (b)	3	9.3.3.3.2	H8
25	4	9.3.1.2.3	H7
26 (a)	2	9.3.4.3.3	H7
26 (b) (i)	2	9.3.3.3.1	H12.3(a), H14.1(c)
26 (b) (ii)	2	9.3.3.3.1	H12.3(a), H14.1(c)
26 (b) (iii)	2	9.3.3.3.1	H12.3(a), H14.1(c)

Question	Marks	Content	Syllabus outcomes
27	3	9.4.2.2.1, 9.4.2.3.2	H9, H13.1(e)
28	4	9.4.3.2.2	H9, H10, H14.1(a)
29	4	9.4.4.2.1	H4, H10, H14(c), (e)
30 (a)	3	9.4.6.3.2	H4, H7
30 (b)	2	9.4.6.3.2	H4, H9
31	7	9.2.1.2.4, 9.2.3.2.2, 9.3.3.3.2, 9.3.5.2.1, 9.4.6.2.1, 9.4.7.3.1	H2, H4, H8, H14.1(f)

Section II

Question	Marks	Content	Syllabus outcomes
Question 32		**Introduced Species and the Australian Environment**	
32 (a)	3	9.5.2.2.2	H10
32 (b)	4	9.5.4.2.1	H7
32 (c) (i)	2	H14.1(a)	H14.1(a)
32 (c) (ii)	4	9.5.5.2.2, 9.5.2.2.1	H7
32 (d) (i)	4	9.5.2.3.1	H11.2(a), H13
32 (d) (ii)	2	9.5.5.3.2	H7
32 (e)	6	9.5.5.2.7, 9.5.5.2.6, 9.5.4.3.1	H9, H10, H13
Question 33		**Organic Geology – A non-renewable Resource**	
33 (a)	3	9.6.6.2.2	H7
33 (b)	4	9.6.3.2.1, 9.6.3.3.1	H7
33 (c) (i)	2	H14.1(a)	H14.1(a)
33 (c) (ii)	4	9.6.1.2.2, 9.6.5.2.3	H7
33 (d) (i)	4	9.6.6.3.2	H11.2(a), H13
33 (d) (ii)	2	9.6.6.2.1	H7
33 (e)	6	9.6.6.2.1, 9.6.5.2.3, 9.6.6.3.2	H6, H7, H13
Question 34		**Mining and the Australian Environment**	
34 (a)	3	9.7.1.2.1	H7
34 (b)	4	9.7.5.2.1, 9.7.5.2.3	H7
34 (c) (i)	2	H14.1(a)	H9, H14.1(a)
34 (c) (ii)	4	9.7.3.3.2, 9.7.3.2.1, 9.7.3.2.6	H6, H7
34 (d) (i)	4	9.7.4.3.2	H11.2(a)
34 (d) (ii)	2	9.7.4.2.2	H7
34 (e)	6	9.7.4.2.1, 9.7.4.2.4, 9.7.4.2.5, 9.7.4.3.1	H6, H7, H13

Question 35		Oceanography	
35 (a)	3	9.8.1.2.2	H7
35 (b)	4	9.8.3.2.4, 9.8.3.2.5	H7
35 (c) (i)	2	9.8.3.3.3	H11.2(a), H14
35 (c) (ii)	4	9.8.3.2.2	H8
35 (d) (i)	4	9.8.6.3.1	H11.2(a)
35 (d) (ii)	2	9.8.6.2.4	H7
35 (e)	6	9.8.5.3.2	H9, H11.2(a), H13