Government of **Western Australia**
School Curriculum and Standards Authority

EARTH AND ENVIRONMENTAL SCIENCE

ATAR course examination 2016

Marking Key

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

2016/65147

Section One: Multiple-choice **15% (15 Marks)**

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

Section Two: Short answer **55% (110 Marks)**

Question 16 **(11 marks)**

(a) For **one** mineral exploration technique, outline how the method is applied in the search for mineralised rocks, and describe the response the method would give if mineralisation was present in the surveyed area. (4 marks)

Description	Marks
Chooses and outlines search method	
Detailed or expansive answer	2
Elementary correct answer	1
sub-total	**2**
Examples of how appropriate techniques work could include: • Geological mapping • Satellite image interpretation • Aerial photograph analysis • Geophysical methods (e.g. magnetics, gravity, seismic, electrical) • Geochemical techniques (e.g. outcrop sampling, lag sampling, stream sediment sampling, soil sampling)	
Describes exploration response	
Detailed or expansive answer	2
Elementary correct answer	1
sub-total	**2**
Examples of : • Localised gravity high, possibly indicating a high-density metal deposit • Soil sampling showing localised region of anomalous gold levels	
Total	**4**
Example answer (for four marks): 'Gravity surveying is performed by taking gravity readings across a region, usually from an aircraft flying a grid pattern. When the readings are assessed, mineralised rocks often show up as gravitational highs.'	

(b) For an area where mineralisation has been located, outline a program of further investigation that could assess the size and grade of the newly-discovered mineral deposit. (3 marks)

Description	Marks
Outlines suitable program	
Detailed description making multiple relevant points of how this program will constrain both deposit size and deposit quality	3
Basic description of how this program will constrain both deposit size and deposit quality	2
Limited description of how this program will constrain **either** deposit size **or** deposit quality	1
Total	**3**
Example answer (for three marks): 'Detailed ground magnetics, to outline general shape of the deposit, followed by drilling and chemical analysis of chips to identify the distribution of grade and further avenues for exploration.'	

(c) Other than the type of mineralisation present, describe **two** factors that would need to be considered before a decision to mine the resource could be made. (4 marks)

Description	Marks
Describes two relevant factors, up to 2 marks each	
Detailed description tied directly to decision making	2
Vague or elementary description	1
Total	**4**
Example of possible factors: • Size, depth and shape of ore body • Grade of ore body • Value of commodity • Availability of a market for the product • Distance from market/port/rail etc. • Availability of workforce • Metallurgy of deposit/suitable processing method • Environmental impact • Native title	

Question 17 **(10 marks)**

(a) Various methods are used to reduce the risk of damage to property such as housing and farm buildings in areas where bushfires are a likely occurrence. Name **one** such method and explain how this method can reduce the risk of damage from bushfires. (2 marks)

Description	Marks
Explains how a method reduces risk of damage	
Detailed explanation	2
Brief or partial description/only names method	1
Total	**2**
Examples of valid methods could include: • Prescribed burning • Clearing of firebreaks • Ensuring adequate supply of water and firefighting equipment	
Example answer for two marks: 'Prescribed burning on a regular basis reduces the fuel load. This makes a damaging bushfire less likely.'	

(b) Climate records show that the regions affected by these bushfires had experienced some of the lowest winter rainfall ever in 2015. Suggest **two** reasons why the very dry winter may have contributed to the number and severity of the fires. (2 marks)

Description	Marks
Gives two reasons, 1 mark each	1–2
Total	**2**
Valid examples could include: • Drying out of vegetation • Lower humidity	

(c) Local weather conditions can influence the spread of bushfires. Name **two** weather conditions that can enhance the spread of bushfires, and describe how each causes this effect. (4 marks)

Description	Marks
Names two weather conditions	1–2
Describes how each condition spreads bushfires	1–2
Total	**4**

Valid examples could include:
- Lightning strikes – set multiple ignition points across a region
- Strong winds – drive flame front and enhance spread of embers
- Direction of winds – driving fire front towards unburnt and/or fuel-heavy areas

(d) In many parts of Australia, natural vegetation that has been severely damaged by bushfires is able to regenerate quickly. Describe an adaptation found in Australian plants that enables them to achieve this rapid regrowth. (2 marks)

Description	Marks
Describes an adaptation	
Detailed description	2
Basic description	1
Total	**2**

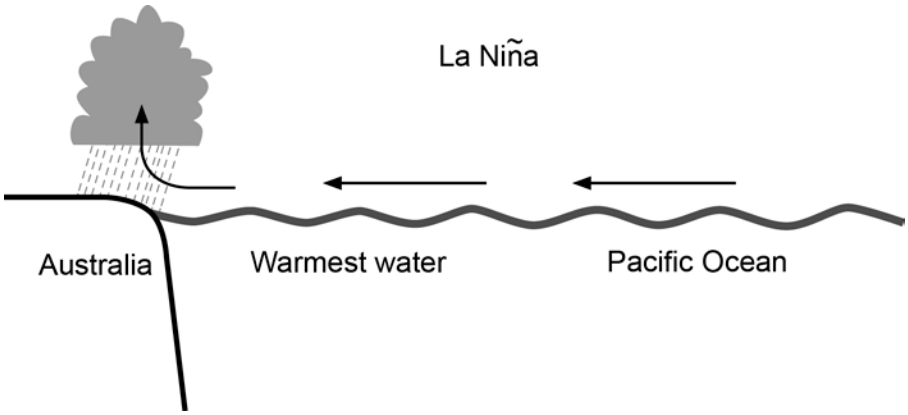
Relevant examples could include:
- Seeds requiring fire to germinate
- Natural resistance of some native species to burning
- Deep tap roots to access water for rapid plant growth

Question 18 **(10 marks)**

(a) In the space below, draw a diagram that represents the Pacific Ocean system during a La Niña event. On your diagram, show the location of Australia, the distribution of the warmest water in the ocean, the horizontal flow of air (wind), and the vertical movement of air. (3 marks)

Description	Marks
Draws labelled diagram	
Warmest water – Western Pacific, off coast of Australia	1
Wind flow – from east to west towards Australia	1
Vertical movement of air upward over coastal eastern Australia	1
Total	**3**

Example diagram for three marks:



(b) In some areas of tropical Australia, the removal of native vegetation and intensive farming leave soils vulnerable to erosion. Flooding in such areas can affect coastal waters and damage coastal marine life, including corals. Describe **two** different ways in which sediment-laden runoff can damage marine life. (4 marks)

Description	Marks
Describes two ways in which sediment-laden runoff damages marine life	
Detailed/integrated answer	2
Elementary answer e.g. identifies process but no other detail	1
Total	**4**

Valid examples could include:

- Increased nutrients in the water from intensive farming - promote growth of algae which smothers aquatic plants
- Increased turbidity (muddiness) in the water – decreases sunlight – restricts aquatic plant growth
- Increased turbidity could also be cited for its potential to choke filter-feeding organisms

Example answer for two marks: 'Eroded sediment makes run-off cloudy, which stops water transmitting light. This can slow down the growth of aquatic plant life in coastal waters, which also reduces the availability of food for primary consumers.'

(c) Heavy rainfall in inland regions that are normally very dry can have a significant impact on the abundance and distribution of plants and animals. Discuss an example of the way in which plant **or** animal life in arid regions of Australia responds to periods of high rainfall. (3 marks)

Description	Marks
Discusses one response to periods of high rainfall	
Detailed well-constructed answer	3
Basic, limited answer	2
Names response or adaptation without discussion	1
Total	**3**

Model answer:

Other valid examples could include:

- Increase in population of insects attracted to plants, seed eating birds etc.
- Increase in population of fish, shrimps etc., providing more food for other animals
- Increase in population of grass-eating animals and water birds, providing food for predators
- Increase in the population of predatory animals

Example answer for three marks: 'In dry periods many plants lie dormant, or even die completely and rely on hardy seeds to maintain their position in the ecosystem. Then in periods of rain, seeds rapidly germinate and grow, and dormant plants flower and set fruit to take advantage of the conditions.'

Question 19 **(12 marks)**

(a) Describe **two** trends apparent in temperature change over time in these data. (2 marks)

Description	Marks
Describes valid trends	
Each of up to two valid trends clearly described.	1–2
Statement of relative trends is sufficient for full marks – students are not expected to quantify the rates of increase.	
Total	**2**
Valid trends could include: • From 1880 to 1960, temperature increases slowly (by 0.4 °C overall – or about 0.05 °C per decade). • From 1960 to 2010 temperature increases much more rapidly (by 0.9 °C overall – or about 0.15 °C per decade)	

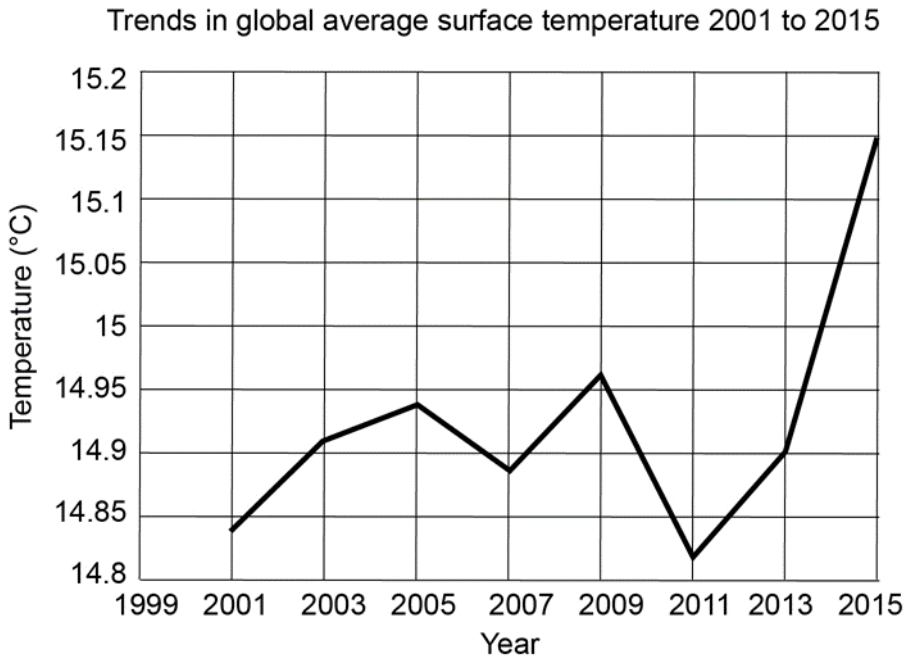
(b) The data collected after 1880 were recorded on well-calibrated, standardised scientific instruments. To study and describe earlier climatic conditions, scientists have used other methods. Name and describe **one** method used to obtain evidence of climatic conditions on Earth that pre-date the development of instrumental measurement. (3 marks)

Description	Marks
Names a method of evaluating climate without scientific instrumentation	1
Describes how this method provides insight into paleoclimate	
Detailed description	2
Elementary or partial description	1
Total	**3**
Valid methods could include: • Written observations and comments on long-term weather events • Tree rings • Fossil record • pollen grains • ice core data • isotope ratios	
Example answer for three marks: 'Tree rings grow thicker in wet years and thinner in dry years. The varying thickness of rings in a sample gives a record of annual conditions through the life of the tree.'	

(c) Using the grid provided on the page opposite, draw a line graph of the data shown in Table B. (5 marks)

Description	Marks
Draws appropriate graph	
Appropriate title – along the lines of 'Trends in global average surface temperature 2001 to 2015'	1
Axes appropriate: time on horizontal, temperature on vertical	1
Units appropriate: time in years, temperature in °C	1
Appropriate choice of scale for both axes	1
Accurate plotting of data	1
Total	**5**

Example graph (for five marks):



(d) Assuming no changes in the factors that now affect the temperature of the atmosphere, use the data in Table A on page 13 and Table B above to predict the change in the average global temperature between 2015 and 2035. Explain your reasoning. (2 marks)

Description	Marks
Predicts and explains change	
Statement is correct and detailed, providing specific quantitative reference to the amount or rate of temperature increase to 2035 **or** Statement is correct and specific in respect to future trend, and explicitly references the data provided within the constrained interval to 2015	2
Statement is nominally correct but vague and lacking explicit reference to the trends in the data provided	1
Total	**2**
Note: Students could look at the consistent temperature rise over the past 4 years and predict a rise to about 16.8 °C, or take a longer term (decadal) view and predict a rise to about 15.2 °C. Other values could be justified.	
Example answer for two marks: 'Recent temperature change 2011–2015 has seen temperature increase at 0.825 °C per decade. Continued heating at these rates would see mean global temperature increase to 16.8 °C by 2035.'	

Question 20 **(11 marks)**

(a) Describe **one** way in which human activity could lead to eutrophication of rivers. (3 marks)

Description	Marks
Describes one way	
Detailed description containing multiple points of content	3
Coherent description with supporting details	2
Elementary and/or vague description	1
Total	**3**
Valid examples include: • Excessive use of fertiliser for agriculture • Release of raw sewage into waterway • Runoff of manure from farms • Discharge of detergents from household usage • Mining activities leading to increased erosion of topsoil	
Example answer for three marks: 'Fertility of farmland is commonly increased by the addition of fertilisers. If more fertiliser is added than plants can absorb, much of the excess is washed off by rain or irrigation, and finds its way into nearby rivers. This leads to enhanced algal growth and subsequent eutrophication.'	

(b) Describe **one** potential consequence of eutrophication for plants and **one** potential consequence to animal life within affected rivers. (4 marks)

Description	Marks
Describes one potential consequence for plants	
Detailed description	2
Elementary or vague description	1
sub-total	**2**
Examples could include • Excessive algal growth could reduce penetration of sunlight, and hence productivity of aquatic plants. • Changes to water chemistry could allow introduced plant species to outcompete native plants.	
Describes one potential consequence for animals	
Detailed description	2
Elementary or vague description	1
sub-total	**2**
Examples could include • Excessive algae growth can lead to oxygen depletion and animal death. • Some predators have difficulty finding prey due to low light levels. • Some types of algal blooms can produce toxins and cause animal death.	
Total	**4**

(c) Suggest **two** methods that are (or feasibly could be) applied to prevent or reduce the level of eutrophication occurring in affected waterways. (4 marks)

Description	Marks
Gives two methods, up to 2 marks each	
Detailed description with multiple points of content	2
Elementary or vague description	1
Total	**4**

Examples could include
- Restrict amount of fertiliser usage
- Change to low phosphorus fertilisers and detergents
- Restrict discharge of sewage into rivers
- Restrict use of septic systems
- Ensure agricultural runoff into waterways from is prevented by using lined dams/earth barriers
- Plant bankside vegetation to produce shade
- Temporary use of algaecides

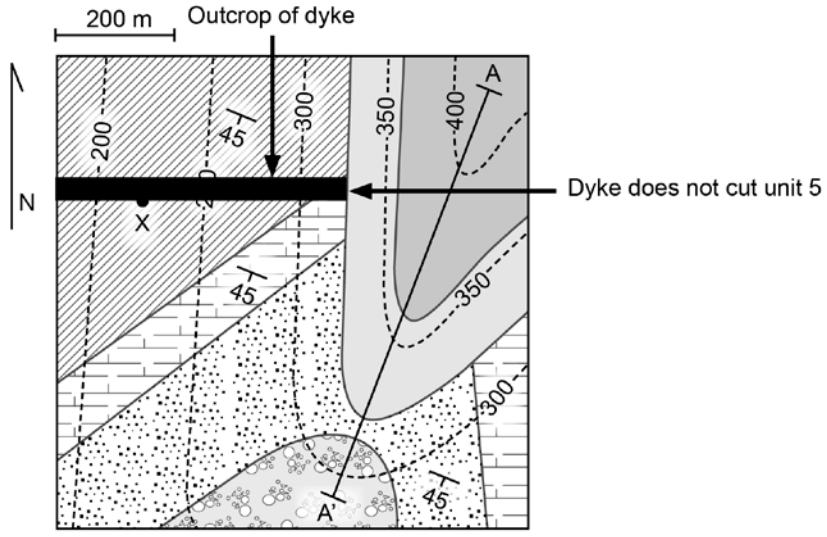
Example answer for two marks: 'Limiting the use of septic tanks to areas further away from the river would reduce the amount of nutrients entering the water.'

Question 21 **(11 marks)**

(a) During fieldwork to test the accuracy of the map, you find a previously-unrecorded basalt dyke cropping out at Point X. Further investigation shows that the dyke is approximately 50 m wide, strikes E-W, intrudes vertically into the country rock and is older than the mudstone unit, but younger than the limestone. Add the dyke as a feature to the map provided, showing its predicted distribution at the surface. (2 marks)

Description	Marks
Draws dyke correctly	
Orientation and approximate dimensions correct	1
Dyke cuts schist and limestone but not mudstone or siltstone	1
Total	**2**

Example answer for two marks:



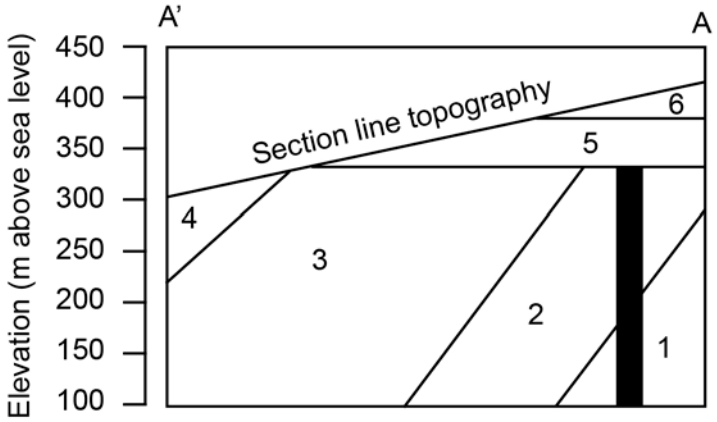
(b) The metamorphism of the schist unit in the north-west of the mapped area would require temperatures and pressures corresponding to many kilometres of burial below the surface, but the overlying unit is an un-metamorphosed marine limestone, deposited in a shallow sea. Outline the geological history required to explain the current relationship of these two units. (2 marks)

Description	Marks
Outlines geological history	
Detailed explanation specifying uplift and erosion to expose the schist, followed by marine inundation and deposition of the limestone	2
Basic explanation defining (either explicitly or implicitly) an unconformable relationship	1
Total	**2**

(c) Produce a cross-section of the region along the line A'–A on the section line provided below. Show the actual or inferred distribution of all lithologies cutting this section line to a depth of 200 m below the lowest point of topography shown, including the dyke added in part (a). (6 marks)

Description	Marks
Draws appropriate cross-section	
Accurate plotting of contacts along section line	1
Mudstone and siltstone units approximately flat lying	1
Lower sequence dipping toward the southern end of the section line at approximately 45°	1
Contacts of lower sequence extrapolated beneath unconformity	1
Location and vertical nature of dike shown accurately/consistent with answer to part (a)	1
Dyke cuts units 1 and 2 but not 5 and 6	1
Total	**6**

Example answer for six marks:



(d) What does the changing lithological character of Units 2, 3 and 4 (shelly limestone, marine sandstone and terrestrial conglomerate) indicate about the variation in local conditions over time during their formation? (1 mark)

Description	Marks
States a valid interpretation	1
Total	**1**
Allowable interpretations include: • Falling sea level • Tectonic uplift	

Question 22 **(11 marks)**

(a) Complete the table below to provide valid names for the features indicated. (3 marks)

Feature	Name
the rock type shown and described above	
the prominent dark, platy mineral present	
the texture created by alignment of the platy minerals in this rock	

Description	Marks
Names features	
Rock type: schist, or some specific variant on that (quartzofeldspathic schist or biotite schist would be allowed). Gneiss is **not** an allowable response	1
Mineral: Enough information is provided that students should recognise it as a dark mica mineral. The expected answer is biotite, but any dark coloured mica is allowable – including phlogopite, zinwaldite, and fuchsite	1
Fabric: The expected answer is schistosity. 'Foliation' is an acceptable alternative, but 'cleavage' is not acceptable, as this describes a rock property, not a texture	1
Total	**3**

(b) List **three** minerals that usually form in the type of rock described above, but do **not** form in sedimentary environments. (3 marks)

Description	Marks
Lists three appropriate minerals, 1 mark each	1–3
Total	**3**

- Biotite
- Muscovite
- Mica – although if this is used, no specific mica (e.g. biotite, muscovite) can also be accepted

Examples could include:

- Plagioclase
- K-feldspar
- Garnet
- Amphibole

Many alternatives are possible.

(c) Describe **two** changes this rock might display if it had experienced higher pressures and temperatures. (2 marks)

Description	Marks
Describes two changes, 1 mark each	1–2
Total	**2**

Examples could include:

- Increase in crystal size of the minerals present
- Intensification of mineral segregation
- Replacement of current mineralogy with new mineral species stable at higher temperature and pressure (e.g. garnet)

(d) A substantial amount of water is usually released during regional metamorphism. Explain how such water can contribute to the formation of economic mineral deposits. (3 marks)

Description	Marks
Provides appropriate explanation	1–3
Detailed explanation making multiple relevant points	3
Clear answer making multiple relevant points	2
Vague or partial response	1
Total	**3**

Example answer for three marks: 'Water is able to dissolve many mineral species and hold them in solution. Such fluids are then able to migrate along grain boundaries and cracks, producing focused flow to concentrate the minerals at specific sites where solubility decreases.'

Question 23 **(12 marks)**

(a) Identify **three** potentially-renewable resources exploited commercially in Western Australia. (3 marks)

Description	Marks
Identifies three resources, 1 mark each	1–3
Total	**3**
Acceptable responses could include: • Rock lobster • Groundwater • Timber • Kangaroos • Snapper • Salt • Wind energy	

(b) The sustainability threshold of a resource represents the level of extraction that is possible without affecting the continued replenishment of that resource. For **one** of the resources identified above, discuss how the sustainability threshold of the resource is (or reasonably could be) determined. (3 marks)

Description	Marks
Explains sustainability threshold determination	
Comprehensive explanation of sustainability threshold determination making multiple significant points	3
Multi-part or detailed explanation of sustainability threshold	2
Basic or partial discussion of appropriate measures to determine sustainability threshold for the chosen resource	1
Total	**3**
Example answer for three marks: 'Calculating the sustainability threshold for the WA snapper fishery would require knowledge of the existing snapper population and the natural replenishment rate of the fish. The snapper population size could be estimated by scientific surveys of the fishery, while replenishment rate would require more detailed studies to determine the breeding rate and growth rate of the snapper, and the natural rates of death and predation on the resource.'	

(c) Describe the likely consequences to this resource if extraction exceeded its sustainability threshold. (3 marks)

Description	Marks
Describes consequences	
Comprehensive explanation of consequences making multiple significant points	3
Coherent statement of consequences making multiple significant points	2
Basic or partial statement of consequence(s) appropriate to the chosen resource	1
Total	**3**
Example answer for three marks (again, continuing the same example from the snapper industry): 'Sustainability thresholds are defined on the basis of a population's ability to replenish itself. If harvesting occurs above this limit, the remaining population is not able to produce enough new fish to replace the catch taken, and the population falls as a result. This reduced population also has a correspondingly lower ability to build numbers up through natural breeding – so that the sustainable yield of the population also decreases. If over-fishing continues over multiple years, the population can collapse dramatically, causing local extinctions and significantly affecting food webs of which the snapper are a part'.	

(d) Discuss how a natural or human-induced process other than commercial extraction might reduce the sustainability of your chosen resource. (3 marks)

Description	Marks
Discusses a process other than commercial extraction	
Relevant process identified and detailed multi-part explanation provided	3
Relevant process identified and limited or partial discussion provided	2
Relevant process identified, but no discussion provided	1
Total	**3**
Depending on the chosen resource, acceptable answers could include: • Industrial pollution • Global warming • De-oxygenation of marine waters Example answer for three marks: 'Natural fish populations are susceptible to outbreaks of disease, particularly when the fish are stressed by other environmental factors such as elevated water temperature or reduced oxygen levels. A substantial disease outbreak could dramatically reduce the local population size and health of snapper – particularly if it occurred in a breeding area. This would reduce the size and replenishment rate of the population, and thus also lower the sustainability threshold for the fishery resource.'	

Question 24 **(11 marks)**

(a) Discuss **two** factors that influence the distribution of heat within the upper 5 km of the Earth's crust. (6 marks)

Description	Marks
For each of two factors that influence heat distribution	
Detailed discussion making multiple relevant points	3
Complete but elementary discussion with no misunderstanding	2
Partial or vague discussion demonstrating limited understanding and/or some misunderstanding	1
Total	**6**
3 marks for **each** of **two** examples given. Answers could include but are not limited to: • Movement of heat with magma • Rapid uplift and erosion exhuming hot rocks close to the surface and producing elevated geothermal gradients • Emplacement of radioactive element rich intrusive bodies	
Example answer for three marks: 'Magma can travel rapidly through the upper crust and convect within large intrusive bodies, carrying heat with it. This moves large amounts of heat energy from hotter, deeper parts of the crust to cooler regions.''	

(b) Identify **two** factors that would be important to consider when evaluating the potential of a region to produce geothermal power. (2 marks)

Description	Marks
Identifies two factors, 1 mark each	1–2
Total	**2**
Factors can include geological, cultural, environmental, and economic. Acceptable answers could include: • Local temperature (or thermal gradient) in the sub-surface • Availability of water • Permeability of high-heat domains • Proximity of potential end-users of power (cities, industrial users)	

(c) Describe a method of exploration or evaluation that would be suitable for investigating **one** of these factors, and explain how it would be applied to assess the geothermal potential of the region. (3 marks)

Description	Marks
Describes an appropriate method	
Detailed and accurate discussion of valid method	3
Valid method and appropriate description, but elementary or with some misunderstandings	2
Valid method cited, but no relevant detail provided	1
Total	**3**
Example answer for three marks: 'Local geothermal gradient can be measured by recording down-hole temperature readings in a borehole that has been left long enough that the thermal disturbance caused the drilling process has been eliminated. By measuring the geothermal gradient in a number of boreholes across the region of interest, the local thermal structure could be mapped out, allowing the identification of the areas most favourable to geothermal energy production.'	

Question 25 **(11 marks)**

(a) Identify and explain an example of how increased food production has contributed to increased levels of methane in the atmosphere. (2 marks)

Description	Marks
Identifies example	1
Explains how increased food production has contributed to increased levels of methane in the atmosphere.	1
Total	**2**
Example answer for two marks (for animal husbandry): 'Increase in the number of cows, sheep, pigs and chicken to produce more food for humans. Animals naturally produce methane when food breaks down in their stomachs and this is released into the atmosphere.' Example answer for two marks (for cropping): 'Dead organic matter created as a by-product of rice farming is left to rot in fields, and methane is released as this breaks down.'	

(b) Explain how increases in atmospheric carbon dioxide, methane and other greenhouse gases contribute to climate change. (3 marks)

Description	Marks
Explains how greenhouse gases contribute to climate change	1–3
Coherent, complete explanation of contribution of greenhouse gases	3
Coherent but incomplete explanation of contribution of greenhouse gases	2
Incomplete, confused explanation of contribution of greenhouse gases	1
Total	**3**
Example answer for three marks: 'Carbon dioxide, methane, and other greenhouse gases absorb infrared energy (heat) released from the Earth's surface into the atmosphere. As the energy is absorbed it causes the temperature of the lower atmosphere to rise. Some of this heat transfers back to Earth's surface. As the volume of greenhouse gases increases, the heating effect in the atmosphere also increases.'	

(c) Rising global temperatures are thought to be already causing changes in the nature and operation of the hydrosphere. Identify and explain a way in which **one** part of the hydrosphere is changing. (3 marks)

Description	Marks
Identifies example	1
Explains the changing hydrosphere	
Coherent, complete explanation of changing hydrosphere	2
Incomplete or confused explanation of changing hydrosphere	1
Total	**3**
Example answer for three marks: 'Increased ocean surface temperatures in tropical regions create more severe tropical cyclones/typhoons. Such storm systems take much of their energy from the warm water. Warmer oceans lead to more evaporation and more heat radiation, and thus to larger, more intense storms.'	

(d) Identify and describe **one** change in energy use that Australia might adopt to reduce the amount of carbon dioxide released to the atmosphere every year, while continuing to meet its energy needs. (3 marks)

Description	Marks
Identifies example	1
Describes changing energy use	
Coherent, complete description of changing energy use	2
Incomplete or confused description of changing energy use	1
Total	**3**
Example answer for three marks: 'We could invest in greater production of electricity from low-carbon or carbon-free sources such as wind or wave power. This would replace use of fossil fuels in gas or coal fired power station, reducing the total amount of CO_2 released.'	

Section Three: Extended response **30% (30 Marks)**

Question 26 (compulsory) **(15 marks)**

(a) Discuss the social and hydrological factors in Western Australia which, over the past 40 years, have decreased the ability of surface water sources to meet the needs of Perth. (5 marks)

Description	Marks
Discusses social and hydrological factors	
Comprehensive and coherent discussion of multiple factors, including both cultural and hydrological elements	4
Effective discussion of one factor with limited and/or ineffectual discussion of other factors	3
Limited discussion of multiple factors from either the cultural or hydrological side of the resource question	2
Limited discussion of a single factor, or of multiple factors with some misunderstanding apparent	1
sub-total	**4**
Links these factors to Perth's water supply needs	
Ties discussion to addressing the resource needs of Perth.	1
sub-total	**1**
Total	**5**

Social factors relevant to this discussion could include:

- rise in the population of Perth over the past 40 years
- profligate water use in Australian (and particularly Western Australian) society
- low density development and resulting urban sprawl
- land use changes in the catchment areas of dams

Hydrological factors could include:

- consistent decrease in rainfall to levels below the historical average
- over-use of ground water resources so that rainfall is soaked up in aquifer recharge rather than running off into surface reservoirs

Neither of these lists is exhaustive, and alternative suggestions should be considered on their merits

Example answer for five marks: 'Rainfall levels in the Perth region have decreased progressively over the past 40 years, leading to lower inflow to the dams and reservoirs that once met the city's water needs. At the same time, the population of the city increased substantially, and the water use per person has also increased as a result of lifestyle aspects such as pools and domestic lawns. These social impacts have been compounded by the low density of development in Perth, which is considered one of the most sprawling cities in the world..'

(b) Identify **two** strategies or policies regarding water use that people in Western Australia have adopted, or could adopt, to reduce their freshwater needs, and describe social or industrial implication of each. (4 marks)

Description	Marks
Identifies two strategies or policies, 1 mark each	1–2
Describes a social or industrial implication of each, 1 mark each	1–2
Total	**4**

For full marks, candidates would need to cite different implications or use substantially different arguments in their discussion of the two factors.
Relevant strategies or processes could include:

- Reduction in the number of swimming pools in the Perth region
- Planting of more native vegetation in place of water-hungry grass and European-style gardens
- Licensing of all bore water users to restrict groundwater extraction
- Reducing domestic water usage – e.g. taking fewer and/or shorter showers, washing cars less
- Charging more for water to discourage use
- Upgrading water distribution systems to reduce or eliminate leaks

Example answer for two marks: 'Charging more for freshwater use would encourage people to use less water, but this might substantially change the Perth landscape by reducing watering of gardens and sports fields, and would make businesses that relied on substantial water use less competitive.'

(c) Surface water (such as rivers, lakes and reservoirs) cannot provide for the projected freshwater needs of Western Australia over the next 20 years. Evaluate the potential of other sources to reduce or solve this problem. (6 marks)

Description	Marks
Evaluates potential of water sources	
Detailed and coherent response covering multiple potential water sources with appropriate supporting arguments	5–6
Expansive and coherently stated response discussing multiple water sources	3–4
Partial or poorly argued response discussing one or two water sources	1–2
Total	**6**
Relevant water sources that might be discussed include: • Groundwater systems in Western Australia • Desalination • Recycling of treated waste water • Savings of water from efficiency programs and changed usage patterns	
Example answer for six marks: 'Perth sits above substantial groundwater resources but these are already heavily extracted. By some estimates they are overused and cannot be relied on to meet greater future need. Desalination is also used to meet current water needs and could be expanded but this is an expensive, energy-intensive process. Perth is also pioneering the use of recycled waste water to recharge aquifers.'	

Question 27 **(15 marks)**

(a) Outline how scientists identify regions at risk from earthquake hazard. (5 marks)

Description	Marks
Outlines how regions at risk are identified	
Earthquake hazard assessment – multiple points combined to build a coherent case	1–5
Total	**5**
Relevant points might include: • Historical record of earthquakes • Monitoring of activity • Mapping of known fault lines • Nature of response of sediments to shaking • Nature of built infrastructure and its response to shaking • Population density	
Example answer for five marks: 'The locations of earthquakes allow us to map the presence of fault lines that might fail again in the future. Earthquakes are caused by a continuing accumulation of tectonic stress. A particular fault structure will usually fail in a consistent way. By knowing the characteristics of previous events, scientists can predict the style, intensity, and distribution of earthquake damage from future events.	

(b) Describe **two** short-term impacts and **one** longer-term consequence on human population or infrastructure that would result from a large earthquake occurring in a heavily-populated area such as a city. (6 marks)

Description	Marks
Describes two short-term effects, up to 2 marks each	1–4
For each effect:	
Detailed multi-point description	2
Vague or elementary description	1
sub-total	**4**
Valid effects could include: • Fires (destroy buildings, kill people) • Building collapse (destroy buildings, kill people) • Loss of utilities (power, water, phone) • Damage to roads	
Describes one long-term impact	1–2
Detailed multi-point description	2
Vague or elementary description	1
sub-total	**2**
Valid examples could include: • Disease • Starvation • Loss of jobs • Increase in homeless • Costs of reconstruction imposing a long-term economic burden	
Total	**6**

(c) Suggest **two** measures that have been (or could reasonably be) taken in earthquake-prone regions to reduce the impact on humans of major earthquakes. (4 marks)

Description	Marks
Describes two measures, up to 2 marks each	1–4
For each measure	
Names and describes the measure	2
Names the measure	1
Total	**4**
Valid examples could include: • Build earthquake resistant buildings • Invest money in earthquake research • Monitor earthquakes • Educate population on earthquake best practice procedures	

Question 28 **(15 marks)**

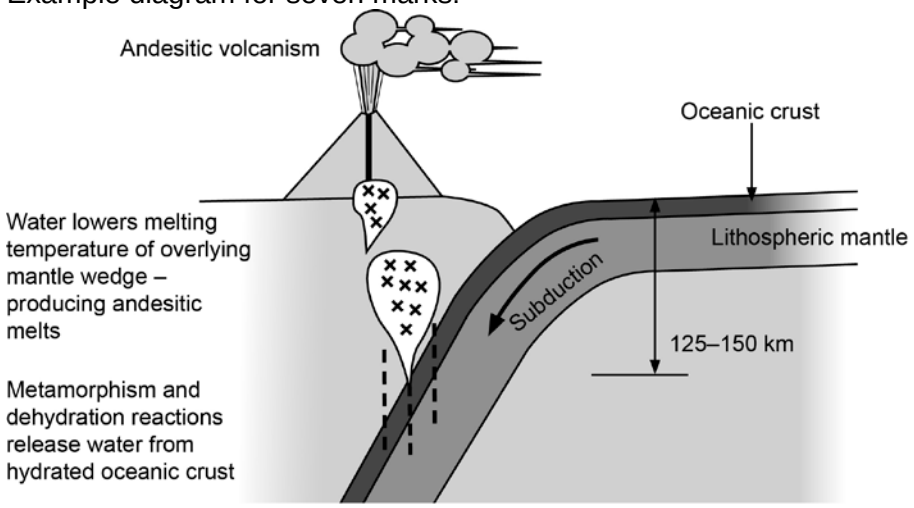
(a) Choose a plate tectonic environment and outline, with the aid of a diagram, how the processes occurring there can lead to the formation of volcanoes and volcanic eruptions. (7 marks)

Description	Marks
Outlines how tectonic process lead to volcanism	1–7
Diagram	
Detailed, accurate, well labelled diagram	3
Well drawn diagram with minor misconceptions and/or more detail needed	2
Simple diagram, lacking labels and/or with some misconceptions	1
sub-total	**3**
Description of tectonic processes	
Detailed and accurate description	2
Appropriate but vague description, and/or incorporating some misconceptions	1
sub-total	**2**
Description of melting/magma production and subsequent formation of volcanoes	
Detailed and accurate description	2
Appropriate but vague description, and/or incorporating some misconceptions	1
sub-total	**2**
Total	**7**

Appropriate examples of tectonic environments could include:

- Subduction zones
- Mid-oceanic ridges
- Hot spots

Example diagram for seven marks:



(b) Describe how magma composition can affect the character of eruption and therefore the hazard potential of a volcano. (4 marks)

Description	Marks
Describes how magmatic composition affects eruptions	1–4
Complete answers should discuss two principal influences	
Silica content and viscosity	
Volatile content and explosive potential	
Detailed and accurate discussion of both factors **and** their interaction with one another	4
Detailed and accurate discussion of both factors	3
Vague or limited discussion of both factors **or** detailed discussion of a single factor	2
Vague or limited discussion of one factor	1
Total	**4**

Example answer for four marks: 'Silica content controls the viscosity of a magma. Silica poor magmas such as basalts have a low viscosity and flow easily, which is hazardous to people and buildings on or near the volcano. Silica rich magmas are more viscous and do not flow under the conditions on the surface of the Earth. This prevents magmatic fluid pressure being relieved by progressive flow and results in more violent eruptive events. Viscous magmas also retain a higher proportion of volatile components such as water and CO_2 released as magma rises toward the surface, allowing gas pressure to rise to explosive levels. Such volcanoes pose a risk to people and buildings over a wide area around the volcano.'

(c) Describe **two** ways by which the emissions from a large volcanic eruption might influence the weather or climate of a region. (4 marks)

Description	Marks
Two influences described, up to 2 marks each	1–4
Detailed description	2
Vague or elementary description	1
Total	**4**

Valid points could include:

- Ash cloud blocking out sunlight and leading to temporary cooling
- Reduced diurnal temperature variation due to ash cloud blanketing effect
- Local increase in rain, lightning, and thunder during an eruption
- The formation of vog, or volcanic fog, causing reduced visibility
- Release of greenhouse gases contributing to global warming
- Introduction of aerosols to the stratosphere altering weather patterns for several years after the eruption

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