



# **EARTH AND ENVIRONMENTAL SCIENCE**

## **ATAR course examination 2019**

### **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.

**Section One: Multiple-choice**

**15% (15 Marks)**

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<b>Question</b>	<b>Answer</b>
1	b
2	a
3	d
4	c
5	b
6	a
7	a
8	b
9	c
10	d
11	c
12	b
13	c
14	a
15	d

## Section Two: Short answer

55% (110 Marks)

## Question 16

(11 marks)

- (a) For each of the metamorphic rock zones shown in the table below, name a rock that you might find in the zone and identify **one** characteristic of that rock. (4 marks)

Description		Marks
For each of <b>two</b> metamorphic rock zones		
Names an appropriate type of rock		1
Identifies an appropriate characteristic of the rock		1
<b>Subtotal</b>		<b>2</b>
<b>Total</b>		<b>4</b>
Sample answers:		
Metamorphic rock zone	Name of rock	Characteristic of the rock
High temperature, low-pressure	<ul style="list-style-type: none"> <li>• quartzite</li> <li>• marble</li> <li>• hornfels</li> </ul>	<ul style="list-style-type: none"> <li>• non-foliated appearance</li> <li>• large interlocking crystals</li> </ul>
Low temperature, intermediate-pressure	<ul style="list-style-type: none"> <li>• slate</li> <li>• phyllite</li> </ul>	<ul style="list-style-type: none"> <li>• fine-grained foliated texture</li> <li>• tendency to break along parallel planes</li> </ul>
Accept other relevant answers.		

- (b) Identify **two** changes that can be caused in metamorphic rock textures by increasing pressure and/or temperature. (2 marks)

Description	Marks
Identifies up to two valid textural changes	1–2
<b>Total</b>	<b>2</b>
Answers could include: <ul style="list-style-type: none"> <li>• presence of foliation/mineral banding</li> <li>• increase in grain size</li> <li>• interlocking crystals.</li> </ul>	
Marker's note: Arrows to indicate increase/decrease are acceptable.	
Accept other relevant answers.	

**Question 16** (continued)

- (c) (i) Name this type of metamorphism. (1 mark)

Description	Marks
Contact metamorphism	1
<b>Total</b>	<b>1</b>

- (ii) Describe how you could distinguish between this type of metamorphism and the effects of regional metamorphic processes. (2 marks)

Description	Marks
Identifies an appropriate distinguishing feature	1
Describes how the feature distinguishes between contact and regional metamorphism	1
<b>Total</b>	<b>2</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• contact metamorphism is localised to margins – increased crystal size</li> <li>• indication of size of zone of metamorphism</li> <li>• there is an absence of foliation which is seen in regional metamorphism.</li> </ul> <p>Sample answer: Directional stress in regional metamorphism produces foliation through the alignment of minerals. The absence of directional stress in a contact metamorphic environment results in the absence of foliation.</p> <p>Accept other relevant answers.</p>	

- (iii) Describe how the water released in dehydration reactions can lead to the formation of mineral resource deposits. (2 marks)

Description	Marks
Describes that the fluid is carrying minerals in solution	1
Describes the precipitation of solids from these solutions, forming mineral deposits	1
<b>Total</b>	<b>2</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• large volumes of mineral-laden water generated</li> <li>• flow through fractures/pathways and precipitation of solids forms a mineral resource deposit.</li> </ul> <p>Sample answer: Metamorphic reactions driven by the heat of granite intrusion may generate large volumes of water through the dehydration of minerals such as mica. These large volumes of fluid flow through fractures and other permeable pathways within the rock and have the ability to transport ore rich fluids. These fluids form the basis of hydrothermal deposits.</p> <p>Marker's note: A diagram may be used to support the answer.</p> <p>Accept other relevant answers.</p>	

Question 17

(13 marks)

- (a) Explain the tectonic processes responsible for the formation of these volcanoes and show the tectonic setting of this area on a labelled cross-sectional sketch. (5 marks)

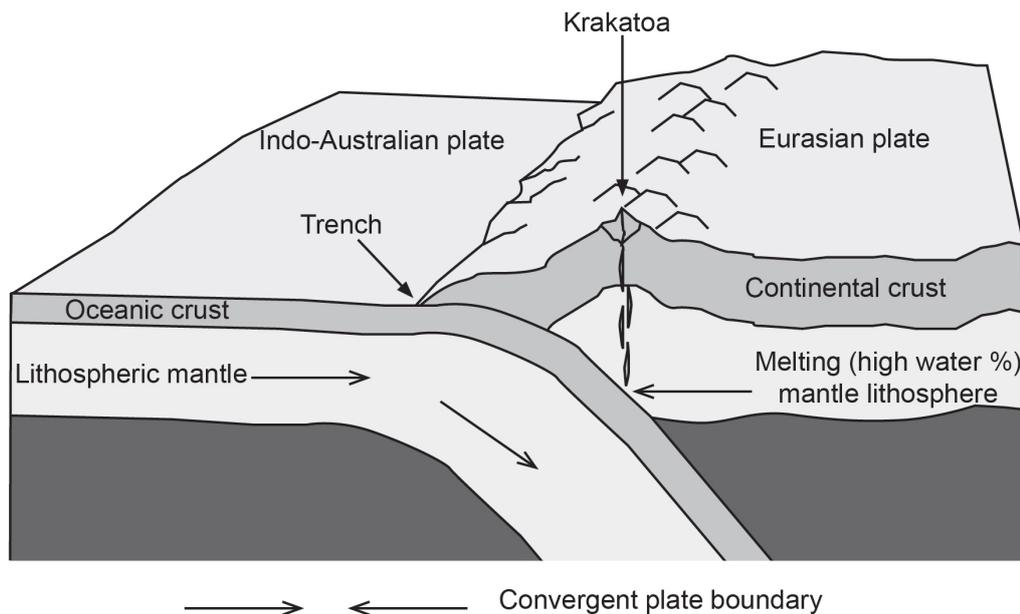
Description	Marks
Explains up to three valid points regarding the tectonic processes responsible for the formation of these volcanoes	1-3
<b>Subtotal</b>	<b>3</b>
Detailed and appropriate labelled cross-sectional sketch	2
Appropriate cross-sectional sketch but lacking labels or containing minor misconceptions	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>5</b>

Answers could include:

- movement of plates creates a convergent plate boundary
- subduction zone results in melting of the over-riding mantle
- magma moving towards the surface forms volcanoes in long arcs
- highly viscous lava forms steep sided volcanoes and results in explosive eruptions.

Sample answer:

The volcanic islands of Krakatoa and Anak-Krakatoa are the result of convergent plate boundaries. At this location, the Indo-Australian plate is being subducted beneath the Eurasian plate. Volcanoes form in long arcs above subduction zones, with eruptions that tend to be extremely explosive due to the high viscosity of the lava.



Marker's note:

The explanation may be presented as separate information or as text added to the cross-sectional sketch.

Accept other relevant answers.

**Question 17** (continued)

- (b) Explain how tsunamis can also be caused by another tectonic process in the absence of volcanism. (4 marks)

Description	Marks
Recognises an earthquake as the tectonic process	1
Explains up to three valid points regarding how a tsunami can be caused by another tectonic processes in the absence of volcanism	1–3
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <p>Earthquake:</p> <ul style="list-style-type: none"> <li>• seafloor upthrust occurs during the tectonic event</li> <li>• upthrust results in the displacement of seawater</li> <li>• displacement generates tsunami waves from the epicentre</li> <li>• waves become larger as they travel into shallower water.</li> </ul> <p>Sample answer:</p> <p>A tectonic event such as an earthquake can cause the sea floor to upthrust. This instantly results in the displacement of massive amounts of seawater, starting a series of tsunami waves that travel outwards from the epicentre of the event.</p> <p>Marker’s note:</p> <p>A diagram may be used to support the answer.</p> <p>Accept other relevant answers.</p>	

- (c) Explain **one** way in which local or global weather patterns might be affected if an eruption similar to the 1883 Krakatoa event occurred today. (4 marks)

Description	Marks
Identifies an appropriate impact	1
Explains up to three valid points regarding one way in which local or global weather patterns might be affected if an eruption similar to the 1883 Krakatoa event occurred today	1–3
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <p>Decrease in global temperature:</p> <ul style="list-style-type: none"> <li>• increased particulate matter in the atmosphere</li> <li>• greater diffusion of incoming solar radiation</li> <li>• less light energy is converted into heat.</li> </ul> <p>Sample answer:</p> <p>A similar eruption would cause a reduction in global temperatures. The eruption would release large amounts of volcanic ash into the stratosphere. These particles act to diffuse incoming solar radiation. With less insolation, less light energy would be absorbed by the surface and converted into heat, reducing global temperatures.</p> <p>Other answers could be based on:</p> <ul style="list-style-type: none"> <li>• localised rainfall events</li> <li>• localised storm events.</li> </ul> <p>Accept other relevant answers.</p>	

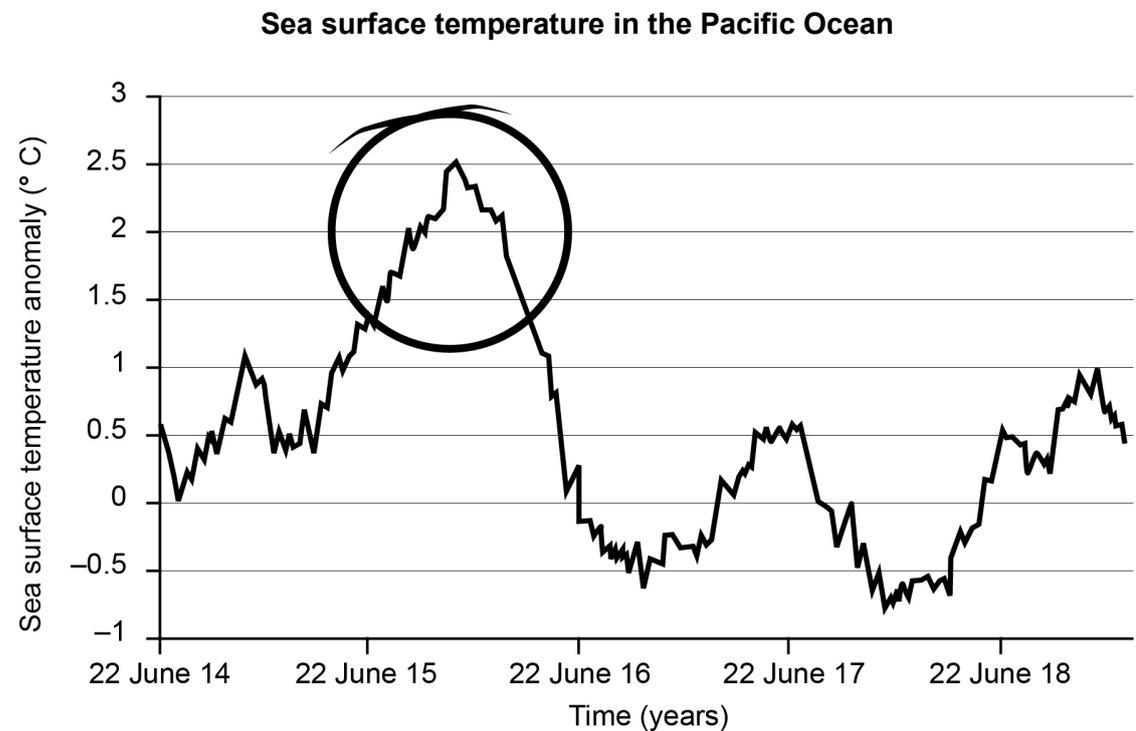
Question 18

(14 marks)

- (a) Draw a circle on the graph to identify a period when El Niño conditions would have been experienced. (1 mark)

Description	Marks
Identifies a period when El Niño conditions would have been experienced	1
<b>Total</b>	<b>1</b>

Sample answer:



Marker's note:

The peak of the graph is the period when El Niño conditions would have been experienced.

**Question 18** (continued)

- (b) In the space below, draw a labelled diagram showing the oceanic and atmospheric conditions in the Pacific Ocean between Australia and South America during an El Niño event. (5 marks)

Description	Marks
For each of the following features on the diagram	
Ocean current direction	1
Location of warm and/or cool surface water	1
Thermocline reduced with no upwelling against South American margin	1
Atmospheric circulation	1
Identification of correct landmasses	1
<b>Total</b>	<b>5</b>
Sample answer:	
Accept other relevant answers.	

- (c) Identify **two** impacts of an El Niño event on weather conditions in eastern Australia. (2 marks)

Description	Marks
Identifies up to two valid impacts of an El Niño event on Australian weather conditions	1–2
<b>Total</b>	<b>2</b>
Answers could include: <ul style="list-style-type: none"> <li>• reduced rainfall/drought</li> <li>• reduction in cyclone activity</li> <li>• warmer temperatures</li> <li>• shift in temperature extremes.</li> </ul>	
Accept other relevant answers.	

- (d) Explain **two** ways in which a forecast of El Niño conditions for the coming season could be used by farmers in eastern Australia to manage their activities. (6 marks)

Description	Marks
For each of <b>two</b> ways	
Explains up to three valid points regarding one way in which a forecast of El Niño conditions for the coming season could be used by farmers in eastern Australia to manage their activities	1–3
<b>Subtotal</b>	<b>3</b>
<b>Total</b>	<b>6</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• rotate fields/rest fields</li> <li>• select drought-tolerant crops and/or livestock</li> <li>• plant crops earlier or later in the season to avoid predicted high temperatures</li> <li>• reduce yield expectations</li> <li>• prepare for increased bushfire risk</li> <li>• delay major infrastructure investments.</li> </ul> <p>Sample answer:</p> <p>Farm management and planning: If El Niño conditions were forecast for the coming season, farmers would know to expect less rainfall. They could plant crops that were drought resistant or that required lower amounts of water as these are more suited to El Niño conditions.</p> <p>Accept other relevant answers.</p>	

**Question 19**

**(12 marks)**

- (a) On the basis of the relationships shown in this diagram, name the geological structures marked as A, B, C, and D. (4 marks)

Description	Marks
A = dyke/intrusion	1
B = unconformity	1
C = fault	1
D = batholith/stock/intrusion	1
<b>Total</b>	<b>4</b>

- (b) Identify the oldest sedimentary rock and the youngest igneous rock present in the region. (2 marks)

Description	Marks
Limestone (oldest sedimentary rock)	1
Dolerite (youngest igneous rock)	1
<b>Total</b>	<b>2</b>

- (c) Outline a geological process that can account for each of the following observations about the geology of the area shown in the block design on page 15.

- (i) Geological data obtained from analysis of rock samples from this region have shown a large age difference between the sandstone and the overlying shale. (2 marks)

Description	Marks
Original overlying layers were removed by uplift and erosion	1
Overlying layers were then deposited	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (ii) The limestone is predominantly fine grained and composed of shell fragments and microfossils, but where it is in contact with the granite, it has a crystalline, sugary texture and no recognisable fossil material. (2 marks)

Description	Marks
Answer shows an understanding of contact metamorphism	1
Recrystallisation of minerals has occurred producing new textures and/or removing fossil material	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (iii) Chemical analysis indicates that the schist is derived from a sedimentary rock with a substantial biological component, but the unit contains no fossils today. (2 marks)

Description	Marks
Any original fossils have been destroyed by heat and pressure	1
During metamorphism	1
<b>or</b>	
There were no fossils in the original sedimentary rock/shale	1
Therefore, no fossils are present in the metamorphic rock/schist	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

**Question 20****(12 marks)**

- (a) This graph shows a sharp increase in carbon emissions from fossil fuel use since the 1940s. Identify **two** possible reasons for this increase. (2 marks)

Description	Marks
Identifies up to two valid reasons for the sharp increase in carbon emissions from fossil fuel use since the 1940s	1–2
<b>Total</b>	<b>2</b>
Answers could include: <ul style="list-style-type: none"> <li>• increase in personal car use</li> <li>• increased number of fossil-fuel based power stations</li> <li>• increased industrialisation in developing countries.</li> </ul>	
Accept other relevant answers.	

- (b) Fossil fuel use is not the only cause of increasing atmospheric CO<sub>2</sub> levels. Describe **one** other human activity that is a significant source of CO<sub>2</sub> emissions. (2 marks)

Description	Marks
Identifies a relevant human activity	1
Describes the human activity that is a significant source of CO <sub>2</sub> emissions	1
<b>Total</b>	<b>2</b>
Answers could include: <ul style="list-style-type: none"> <li>• burning of forests – CO<sub>2</sub> released from organic matter</li> <li>• deforestation – CO<sub>2</sub> released by decomposition</li> <li>• agriculture – CO<sub>2</sub> released during management of croplands and livestock</li> <li>• industrial processes – CO<sub>2</sub> released during the production of lime, cement.</li> </ul>	
Sample answer: Industrial processes:	
<div style="border: 1px dashed gray; padding: 10px; margin: 10px auto; width: 80%;">             For copyright reasons this text cannot be reproduced in the online version of this document, but may be viewed at the link listed on the acknowledgements page.           </div>	
Accept other relevant answers.	

**Question 20** (continued)

(c) With the aid of a diagram, explain how the enhanced greenhouse effect influences global temperatures. (4 marks)

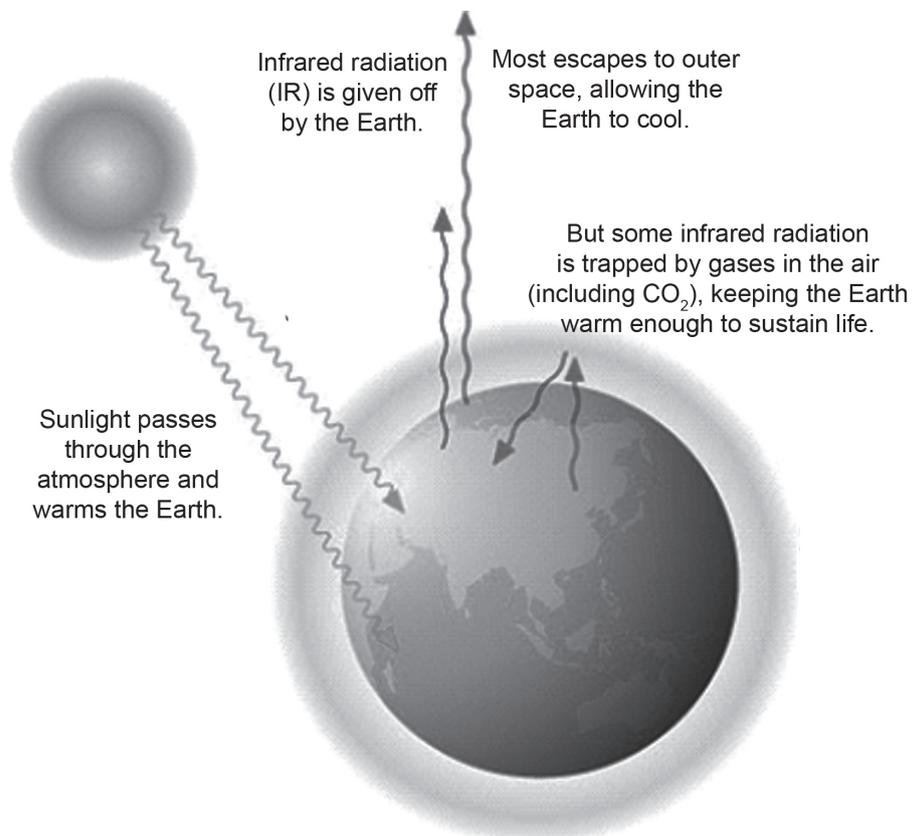
Description	Marks
Includes an appropriate diagram that aids the answer	1
Explains up to three valid points regarding how the enhanced greenhouse effect influences global temperature	1–3
<b>Total</b>	<b>4</b>

Answers could include:

- incoming solar radiation enters the atmosphere but does not heat it
- following absorption, the solar radiation is converted to infrared radiation
- some infrared radiation is trapped by atmospheric greenhouse gases
- trapped radiation helps to maintain the earth at a liveable temperature
- increasing levels of greenhouse gases in the atmosphere ‘enhances’ or strengthens the greenhouse effect, leading to global warming.

Sample answer:

The sun’s energy enters the atmosphere, but most of this escapes back to space. However, increased CO<sub>2</sub> levels can lead to the atmosphere trapping a larger proportion of the sun’s energy. This process is referred to as the enhanced greenhouse effect and can lead to increased average global temperatures.



**Enhanced greenhouse effect.**

Increasing levels of CO<sub>2</sub> increase the amount of heat retained, causing the atmosphere and the Earth’s surface to heat up.

Marker’s note:

The explanation may be presented as separate information or as text added to the diagram.

Accept other relevant answers.

- (d) Identify **two** possible consequences of increased global temperatures and **one** effect of each on human society. (4 marks)

Description	Marks
For each of <b>two</b> possible consequences	
Identifies a possible consequence	1
Identifies one effect of the consequence on human society	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• rising sea levels – leading to the inundation of coastal towns</li> <li>• more frequent extreme weather events such as storms and cyclones – cost of replacing damaged infrastructure</li> <li>• hotter weather/more frequent droughts – reduced water supply to farming systems</li> <li>• disruption of ecosystems – threatens ecosystem services on which humans depend</li> <li>• spread of some pests and diseases – affecting crop yields.</li> </ul> <p>Sample answer: Rising sea levels: A consequence of increased global temperatures is rising sea levels. The effect of this will be an increase in coastal erosion and inundation in low-lying settlements.</p> <p>Accept other relevant answers.</p>	

**Question 21**

**(11 marks)**

- (a) Describe **two** ways in which the geographic location of a resource could influence a decision about whether or not to mine it. (4 marks)

Description	Marks
<b>For each of two ways</b>	
Identifies an appropriate way	1
Describes the way in which the geographic location of a resource could influence a decision about whether or not to mine it	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
<p>Answers could include:                      Location of a resource can affect:</p> <ul style="list-style-type: none"> <li>• proximity to port/rail network – impacts the cost of transport</li> <li>• political stability of geographic location – impacts access/safety</li> <li>• distance to workforce – affects the availability of labour</li> <li>• available power/water – impacts the costs involved in setting up the mine</li> <li>• proximity to areas of cultural significance</li> <li>• closeness to sensitive ecosystems – may prevent a mine being established.</li> </ul> <p>Sample answer:                      Proximity to port:                      A short distance between a potential mine site and a port increases the viability of the project by reducing the costs involved in transporting the resource.</p> <p>Accept other relevant answers.</p>	

- (b) Describe how the method used for the extraction of a mineral or energy deposit could be influenced by the: (4 marks)

- concentration of the resource.
- physical distribution of the resource.

Description	Marks
<b>The concentration of the resource</b>	
Identifies an appropriate aspect of resource concentration	1
Describes how the concentration of the resource could influence the method used in its extraction	1
<b>Subtotal</b>	<b>2</b>
<b>The physical distribution of the resource</b>	
Identifies an appropriate aspect of resource distribution	1
Describes how the physical distribution of the resource could influence the method used in its extraction	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
<p>Sample answer:                      The concentration of the resource:                      Low-grade ore bodies are unlikely to be economic using underground techniques due to high cost of this method. It is more likely that an open-cut method would be used to extract this type of resource.</p> <p>The physical distribution of the resource:                      Ore body shape is an important factor in mine design. For example, a spread out, irregular shaped ore body, may be more suited to underground mining methods due to the high proportion of waste that would need to be removed if it was mined using an open cut pit.</p> <p>Accept other relevant answers.</p>	

- (c) Explain why the government requires mining companies to consult and/or negotiate with local communities in assessing the viability of a potential mine. (3 marks)

Description	Marks
Explains up to three valid points regarding the government requirement that mining companies consult and/or negotiate with local communities	1–3
<b>Total</b>	<b>3</b>
Answer could include: <ul style="list-style-type: none"><li>• necessity for community to raise issues</li><li>• recognition of legal rights and obligations</li><li>• respect the need for negotiation</li><li>• there is a responsibility to resolve issues</li><li>• community may contribute knowledge.</li></ul>	
Sample answer: Consultation is required so that mining companies engage with local communities. This gives local communities the opportunity to voice any concerns that they might have with the project and to negotiate in areas that the community feels are important (for example, jobs and the environment). Consultation also allows local communities the chance to contribute knowledge which may be useful to the project.	
Accept other relevant answers.	

**Question 22**

**(13 marks)**

- (a) Describe how the amalgamation or breakup of continents during the super-cycle might affect oceanic currents and the impact of these changes on global climate. (4 marks)

Description	Marks
<b>Effect on oceanic currents</b>	
Identifies creation of new currents/ending of previous currents	1
Describes relevant continental movement	1
<b>Subtotal</b>	<b>2</b>
<b>Impact on global climate</b>	
Identifies an appropriate impact	1
Describes the impact of changes in oceanic currents on global climate	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <p>Effect on oceanic currents:</p> <ul style="list-style-type: none"> <li>• breakup of continents (i.e. rifting) may create new currents</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>• amalgamation of continents may end currents that previously existed.</li> </ul> <p>Impact on global climate:</p> <ul style="list-style-type: none"> <li>• oceanic currents play a role in transporting energy</li> <li>• a change in oceanic currents may therefore impact climate (i.e. warm oceanic currents create warmer climates).</li> </ul> <p>Sample answer:</p> <p>When a continent rifts apart, it allows oceanic flow to develop in new areas of the planet. Since they play a significant part in the distribution of energy on the planet, changes to oceanic currents would have a significant effect on the climate. For example, if the separation of a continent allowed a warm current to develop, a previously cold region would start to experience a warmer climate.</p>	
Accept other relevant answers.	

- (b) Explain **two** ways in which mountain ranges or other changes caused by plate movement can affect the climate of a continent. (6 marks)

Description	Marks
For each of <b>two</b> ways	
Explains up to three valid points regarding a way in which mountain ranges or other changes caused by plate movement can affect the climate of a continent	1–3
<b>Subtotal</b>	<b>3</b>
<b>Total</b>	<b>6</b>
<p>Answers could include:</p> <p>Effects of mountain ranges on the climate of a continent:</p> <ul style="list-style-type: none"> <li>• creation of orographic rainfall and rain shadow effect</li> <li>• areas of altitude will be cooler due to lowering of air pressure</li> <li>• can create strong winds</li> <li>• creation of areas of snowfall within elevated regions</li> <li>• elevated regions may enhance glacial development, creating microclimates.</li> </ul> <p>Sample answer:</p> <p>When air moves over mountains, it is forced to rise. This causes the air to cool, become saturated and rainfall to develop, in a process known as orographic rainfall. When the air finally reaches inland areas, it lacks moisture and this causes a desert climate. The coastal side of the mountains will receive the majority of the rainfall producing a wetter, more humid climate.</p> <p>Marker's note:</p> <p>A diagram may be used to support the answer.</p> <p>Accept other relevant answers.</p>	

- (c) Explain why scientific models are continuously being replaced or updated. (3 marks)

Description	Marks
Explains up to three valid points regarding why scientific models are continuously being replaced or updated	1–3
<b>Total</b>	<b>3</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• scientists use models to explain evidence</li> <li>• the models reflect scientific understanding at the time</li> <li>• new scientific data or evidence may be found</li> <li>• scientific models may be updated or changed completely by new evidence.</li> </ul> <p>Sample answer:</p> <p>One reason a scientific model may change is that new scientific studies are continually increasing the amount of data on a particular topic. This results in new and/or important understandings. The model may then be updated or replaced to reflect these understandings, as a scientific model reflects the data and the thinking of the scientists at the time it was proposed.</p> <p>Accept other relevant answers.</p>	

**Question 23**

**(11 marks)**

- (a) For **one** specific ecosystem you have studied, describe **two** ways in which human activities have changed or could potentially change the ecosystem. (4 marks)

Description	Marks
For each of <b>two</b> ways	
Identifies an appropriate change	1
Describes the way in which human activities have changed or could potentially change the ecosystem	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• destruction of habitats due to clearing for residential development</li> <li>• disruption of food chains and food webs by human intervention</li> <li>• introduction of species (i.e. weed seeds brought in on machinery)</li> <li>• pollution of water</li> <li>• noise and/or light could scare off important prey</li> <li>• physical separation of breeding populations.</li> </ul> <p>Sample answer: Introduction of species: Human activities can lead to introduced plant seeds being accidentally brought into the area. This can lead to a population of the introduced species developing and the possible replacement of the native plant species.</p> <p>Accept other relevant answers.</p>	

- (b) Describe **two** ways in which scientists have gathered or could potentially gather information to assess the extent of change to an ecosystem. (4 marks)

Description	Marks
For each of <b>two</b> ways	
Identifies an appropriate way	1
Describes the way in which scientists have gathered or could potentially gather information to assess the extent of change to an ecosystem	1
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>• river/groundwater sampling (before and after activity)</li> <li>• air quality sampling</li> <li>• animal/plant population surveys</li> <li>• aerial photography</li> <li>• animal tagging to monitor movement</li> <li>• trapping/weighing/assessing health of animals.</li> </ul> <p>Sample answer: Animal/plant population surveys: Scientists can conduct a survey of the animal and plant species in the surrounding area. This could be done by a combination of aerial photos, surface mapping and animal trapping to determine how the number of plants and animals has or is changing over time.</p> <p>Accept other relevant answers.</p>	

- (c) Explain how scientific data collected on ecological change could be used to ensure that human activity is conducted in a more environmentally sustainable manner. (3 marks)

Description	Marks
Explains up to three valid points regarding how scientific data could be used to ensure that human activity is more environmentally sustainable	1–3
<b>Total</b>	<b>3</b>
Answer could include: <ul style="list-style-type: none"><li>• monitoring of ecosystem to provide a base level for change management</li><li>• detection of changes and problems</li><li>• inputs to ecological modelling as a management tool</li><li>• enables remediation before changes become irreversible.</li></ul>	
Sample answer: Data from the sampling of river and groundwater, for example, could be used to ensure that human activity is not changing the composition of the water. By comparing regular samples of the water to samples taken in the past (i.e. ideally, prior to commencement of human activity), it is possible to identify an increase in any environmentally hazardous substances. Studies could then be undertaken to identify the cause and determine the best action to be taken to reduce the effect.	
Accept other relevant answers.	

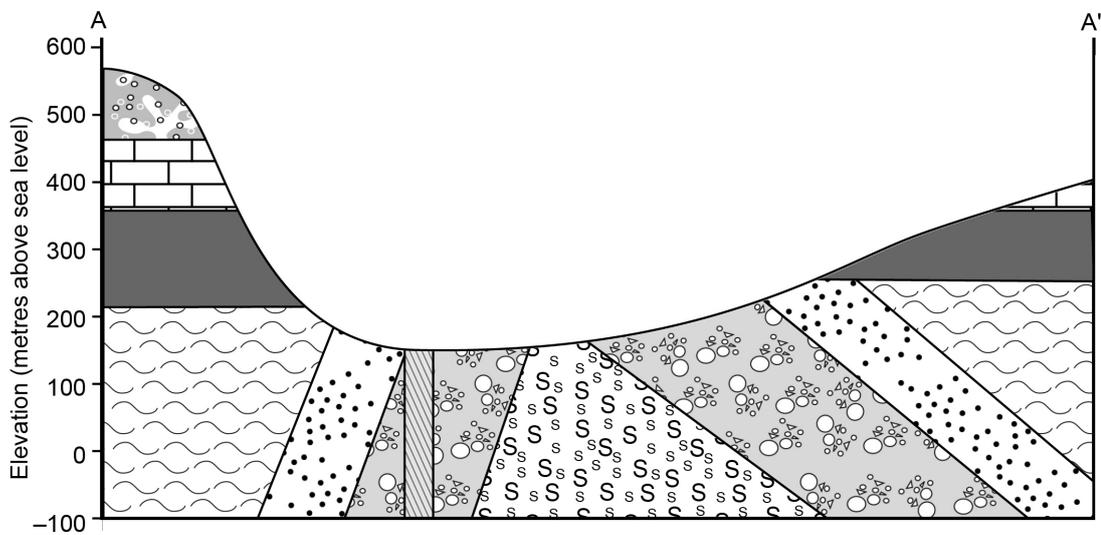
**Question 24**

**(13 marks)**

- (a) Construct 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 down to 100 metres below sea level. Note: to assist you in transcribing data locations, you may remove page 45 by tearing along the perforations. (7 marks)

Description	Marks
For each of the following features on the cross-section	
Appropriate topography	1
Contacts shown in appropriate positions	1
Basalt 2, shelly limestone and coral reef units flat lying	1
Unconformable relationship between basalt 2 and underlying units (mudstone, sandstone, conglomerate, schist)	1
Anticlinal fold structure shown	1
Western limb dips much more steeply than eastern limb (70° vs 30°)	1
Basalt 1 shown as a vertical dyke at an appropriate point	1
<b>Total</b>	<b>7</b>

Sample answer:

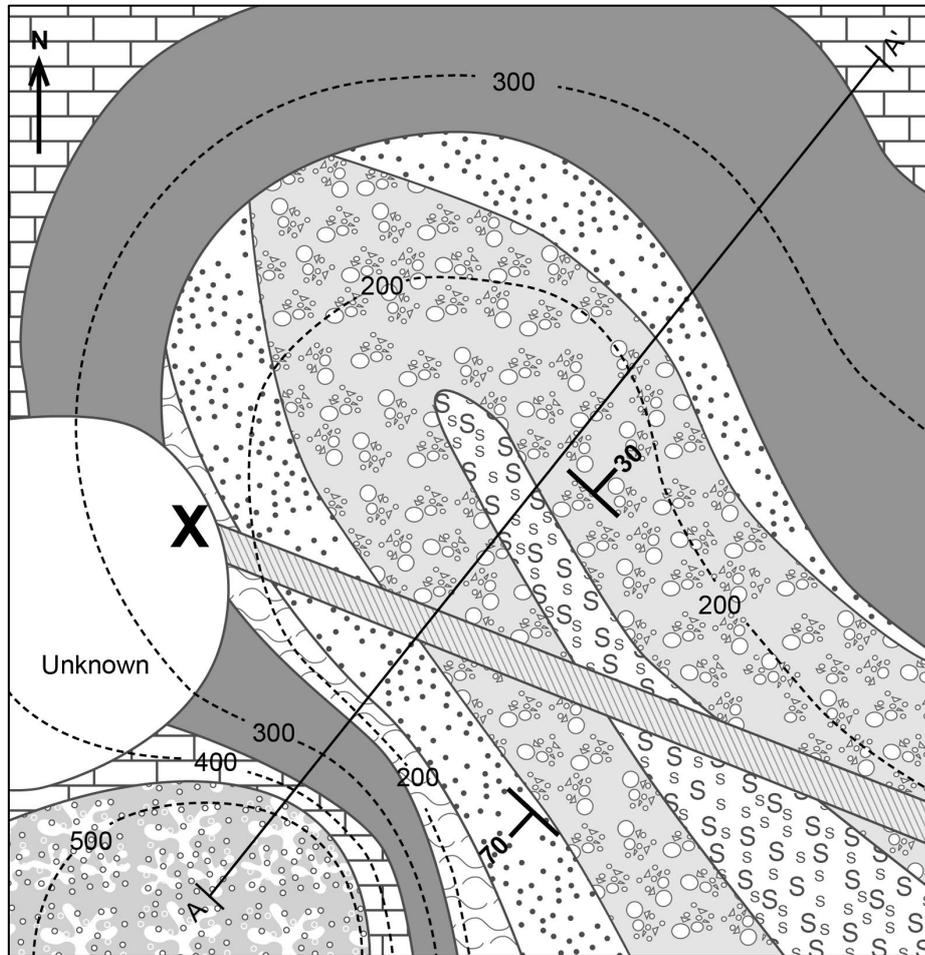


Accept other relevant answers.

- (b) Mark an **X** on the map on page 26 where you predict the contact between basalts 1 and 2 might be exposed. (1 mark)

Description	Marks
Marks an X at the appropriate point on the map	1
<b>Total</b>	<b>1</b>

Sample answer:



Marker's note:

The predicted location could justifiably be placed anywhere that the contact of basalt 1 projects across the inferred distribution of basalt 2.

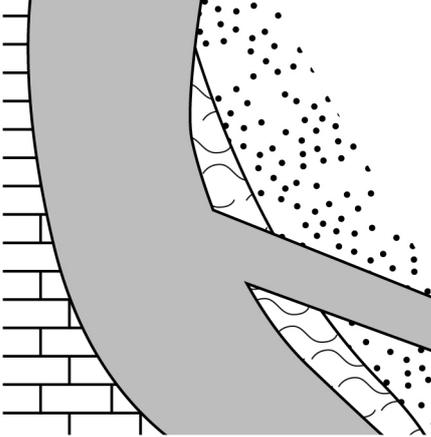
**Question 24** (continued)

(c) If this contact is exposed, describe or sketch the relationship you would see between basalt 1, basalt 2 and the shelly limestone if:

(i) basalt 1 feeds into basalt 2. (2 marks)

Description	Marks
Basalt 1 and basalt 2 form a continuous unit with no contact between them	1
The shelly limestone overlies the basalt	1
<b>Total</b>	<b>2</b>

Sample answer:

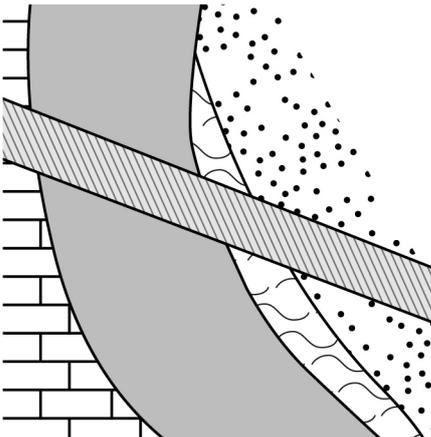


Marker's note:  
The answer may be described in words and/or sketched.

(ii) basalt 1 is younger than basalt 2. (2 marks)

Description	Marks
Basalt 1 cuts basalt 2	1
Basalt 1 cutting the shelly limestone	1
<b>or</b>	
Basalt 1 and basalt 2 being overlain by the shelly limestone across an erosion surface/unconformity	1
<b>Total</b>	<b>2</b>

Sample answer:

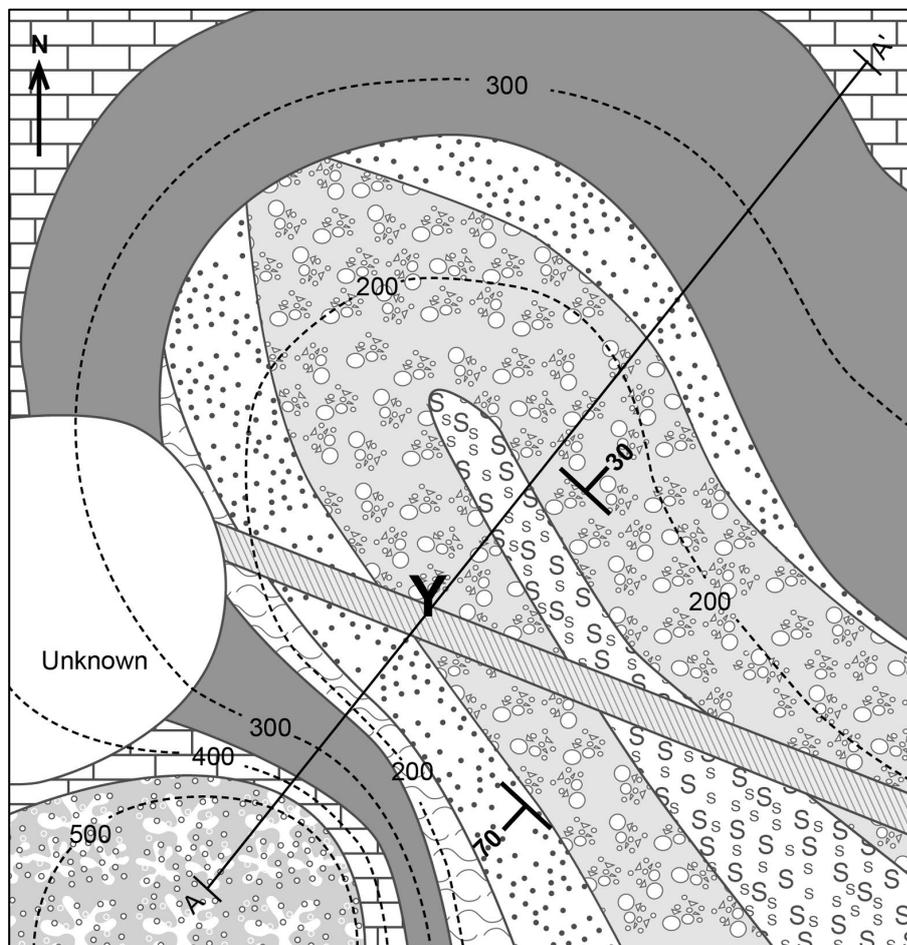


Marker's note:  
The answer may be described in words and/or sketched.

- (d) Mark a Y on the map on page 26 where your cross-section predicts a vertical hole would encounter this feature of interest. (1 mark)

Description	Marks
Marks a Y at the appropriate point on the map	1
<b>Total</b>	<b>1</b>

Sample answer:



**Section Three: Extended answer**

**30% (30 Marks)**

**Question 25**

**(15 marks)**

- (a) On the basis of the information with which you have been provided regarding the site, identify **three** different hazards that an earthquake on this fault structure could pose for the resort and its guests. (3 marks)

Description	Marks
Identifies up to three valid hazards that an earthquake on this fault structure could pose for the resort and its guests	1–3
<b>Total</b>	<b>3</b>
Answers could include: <ul style="list-style-type: none"> <li>• severe ground shaking damaging buildings and infrastructure</li> <li>• structural collapse of buildings and falling debris could cause injury or fatality</li> <li>• unconsolidated sediments could experience liquefaction during severe shaking, causing damage and collapse of structures</li> <li>• strong ground shaking could trigger landslides/mudslides</li> <li>• submarine earthquakes or landslides could cause tsunamis.</li> </ul> Accept other relevant answers.	

- (b) Identify **two** types of data that you could research and describe how these could be used to determine the frequency and magnitude of earthquakes that have occurred on this fault structure in the past. (6 marks)

Description	Marks
For each of <b>two</b> types of data	
Identifies a type of data that could be researched	1
Describes how the data could be used to determine the frequency of earthquakes that have occurred on this fault structure in the past	1
Describes how the data could be used to determine the magnitude of earthquakes that have occurred on this fault structure in the past	1
<b>Subtotal</b>	<b>3</b>
<b>Total</b>	<b>6</b>
Answers could include: <ul style="list-style-type: none"> <li>• trenching of the fault to measure magnitude of offsets</li> <li>• dating layers to develop historic record of earthquake frequency</li> <li>• records of recent movements or earthquake events in old newspapers, documents or oral histories to study recent frequency of earthquakes</li> <li>• evidence of simultaneous movement and shaking over large distances</li> <li>• evidence of the hazard effects outlined in part (a).</li> </ul> Sample answer: A probabilistic hazard can be assigned to fault segments with a known history of activity but an absence of recent seismic activity. This can reflect a locked fault segment building up stress that will eventually be released in an earthquake. By using the history of earthquake timing and size on a locked structure, the rate of stress build up and characteristic period between failure events could be estimated. These quantities can be used to evaluate earthquake hazard around a known structure.                     Accept other relevant answers.	

- (c) Write a hazard mitigation report for the company explaining **two** measures it could take in the construction or operation of its resort facilities to reduce the risk posed to its guests by this fault structure. (6 marks)

Description	Marks
For each of <b>two</b> measures	
Explains up to three valid points regarding a measure that the company could take in the construction or operation of its resort facilities to reduce the risk posed to its guests by this fault	1–3
<b>Subtotal</b>	<b>3</b>
<b>Total</b>	<b>6</b>
<p>Measures could include:</p> <ul style="list-style-type: none"> <li>• incorporating elements of earthquake resistance into buildings</li> <li>• avoid building in hazardous locations (i.e. on a steep hill or at sea level)</li> <li>• tsunami warning systems</li> <li>• educating population on earthquake best practice procedures</li> <li>• practice building evacuations</li> <li>• abandon the project and/or seek alternative site.</li> </ul> <p>Sample answer: Incorporating elements of earthquake resistance into buildings: The company could ensure that buildings at the site are constructed to be earthquake resistant. This could include insulating the foundations of the buildings from the vibrations of an earthquake. Another method could be to incorporate steel braced construction which increases the ability of a building to withstand the forces of an earthquake.</p> <p>Marker's note: A diagram may be used to support the answer.</p> <p>Accept other relevant answers.</p>	

**Question 26**

**(15 marks)**

For one renewable resource:

- (a) (i) state why the resource can be considered to be renewable. (1 mark)

Description	Marks
States why the resource can be considered to be renewable	1
<b>Total</b>	<b>1</b>
Answer could be based on, but is not limited to: <ul style="list-style-type: none"> <li>• solar energy</li> <li>• wind energy</li> <li>• wave energy</li> <li>• geothermal energy.</li> </ul> Sample answer: Wind energy: Wind energy is a renewable resource. It is renewable because it is replaced/renewed naturally at a rate that is at least equal to that at which it is removed/used.  Marker's note: Answer must identify the resource.  Accept other relevant answers.	

- (ii) describe how energy is produced from this resource and stored and/or transferred. (4 marks)

Description	Marks
Describes up to two valid points regarding how energy is produced from the resource	1–2
Describes up to two valid points regarding how energy from the resource is stored and/or transferred	1–2
<b>Total</b>	<b>4</b>
Sample answer: The energy of the wind is harnessed by converting the kinetic energy in wind to electrical energy. Wind is used to turn a large wind turbine (consisting of a number of propellers), which is connected via a gearbox to a generator that converts the mechanical energy to electrical energy. The electricity produced by the generator is in the form of direct current. It can be stored in a battery system or distributed immediately to consumers. To distribute the electricity, it is converted to alternating current and fed into a grid system consisting of wires. This system will eventually transfer the energy to consumers that are attached to the grid.  Accept other relevant answers.	

- (b) Describe **two** environmental factors that are important in selecting a suitable location for the production of this resource. (4 marks)

Description	Marks
For each of <b>two</b> environmental factors	
Describes up to two valid points regarding a factor that is important in selecting a suitable location for the production of the resource	1–2
<b>Subtotal</b>	<b>2</b>
<b>Total</b>	<b>4</b>
Sample answer: Wind energy: Strong winds will cause wind turbines to turn more quickly and will therefore generate greater amounts of electricity. Albany, for example, is known for its strong winds, making it an ideal location for a wind farm. The consistency of the wind is also an important factor when selecting a suitable location for the production of wind energy. Coastal regions that have regular afternoon sea breezes or places that are exposed to consistent 'trade winds' would be most suitable, as the turbines will turn more often.	
Accept other relevant answers.	

- (c) Explain **two** factors that affect the cost effectiveness of using this resource. You may consider economic, environmental or political factors in your answer. (6 marks)

Description	Marks
For each of <b>two</b> factors	
Explains up to three valid points regarding how the factor affects the cost effectiveness of using the resource	1–3
<b>Subtotal</b>	<b>3</b>
<b>Total</b>	<b>6</b>
Sample answer: Wind energy: The cost effectiveness of wind turbines is partly determined by the scale of the system. Small-scale systems may be cheaper to install, but they may be more expensive than larger, more expensive systems on the basis of cost per kilowatt of energy produced. Also, when electricity is transmitted through wires and moved through transformers, it loses energy in the form of heat. The further the electricity travels from point of generation to point of use, the greater the energy lost, and the less cost effective it is to use the resource.	
Accept other relevant answers.	

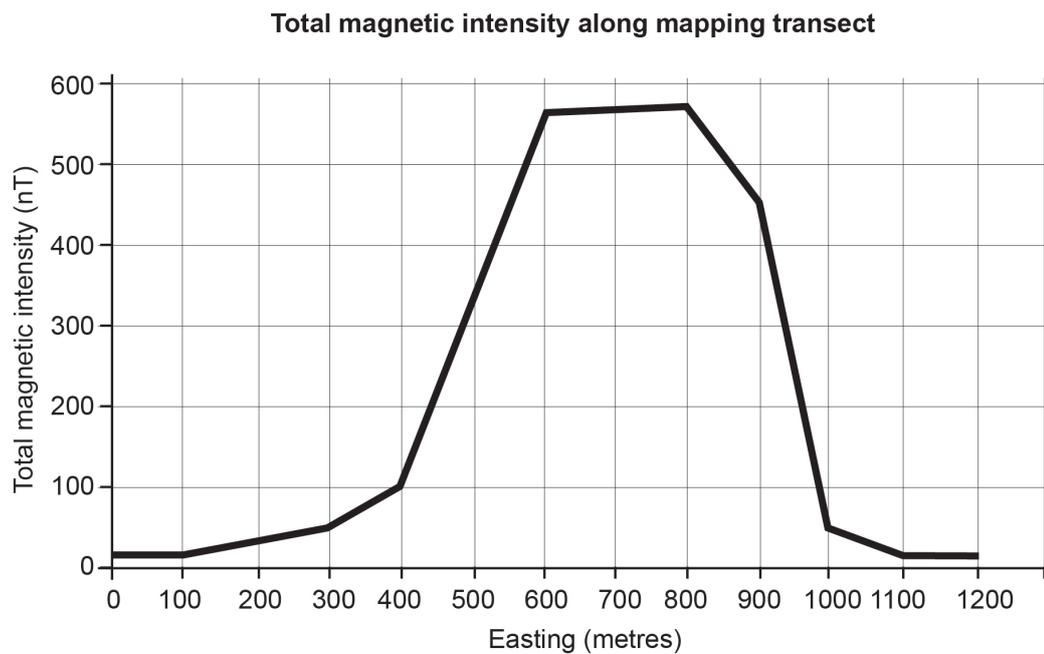
**Question 27**

**(15 marks)**

- (a) On the grid provided below, draw a line graph of the total magnetic intensity recorded along the transect A-B. (5 marks)

Description	Marks
For each of the following features on the line graph	
An appropriate title including independent and dependent variables	1
X and Y axes labelled correctly	1
Units provided for axes	1
Data points are plotted correctly	1
Data line is drawn accurately	1
<b>Total</b>	<b>5</b>

Sample answer:



Accept other relevant answers.

- (b) State the location in eastings and identify the target lithology where you would undertake further exploration. Outline **two** reasons for your decision. (4 marks)

Description	Marks
States the location in eastings where further exploration would be undertaken	1
Identifies the target lithology where further exploration would be undertaken	1
Outlines up to two valid reasons regarding the decision about where to undertake further exploration	1–2
<b>Total</b>	<b>4</b>
<p>Answers could include:</p> <p>Location:</p> <ul style="list-style-type: none"> <li>eastings between 400 and 900.</li> </ul> <p>Target lithology:</p> <ul style="list-style-type: none"> <li>granite.</li> </ul> <p>Reasoning:</p> <ul style="list-style-type: none"> <li>high magnetic anomaly in this section of the transect</li> <li>granite is igneous – often associated with ores</li> <li>granite extends at depth below the surface.</li> </ul> <p>Sample answer:</p> <p>Further exploration should be conducted between eastings 400 and 900 and the target lithology is the granite. Mineral deposits generally have physical properties that are different to the surrounding rocks and the traverse of total magnetic intensity shows an anomaly in this area. The granite would be the target lithology because magnetic minerals tend to be more common in igneous rocks than sedimentary rocks. Additionally, metal ores are generally magnetic. The target area is bigger than the exposed granite as the anomaly indicates that the granite extends at depth.</p> <p>Accept other relevant answers.</p>	

- (c) Describe **two** other suitable exploration techniques that could help you to refine the location of the mineral resource that you believe may be present at this site. Outline the response you would expect from each technique. (6 marks)

Description	Marks
For each of <b>two</b> other suitable exploration techniques	
Identifies an appropriate exploration technique	1
Describes how the exploration technique could help to refine the location of the mineral resource	1
Outlines the response that is expected from this technique	1
<b>Subtotal</b>	<b>3</b>
<b>Total</b>	<b>6</b>
<p>Answers could include:</p> <ul style="list-style-type: none"> <li>diamond drilling</li> <li>surface geochemical sampling</li> <li>high resolution gravity studies.</li> </ul> <p>Sample answer:</p> <p>Diamond drilling could help refine the location of the mineral resource. A drill core is used to create a three dimensional geological map of the target area. An assay of the core sample would provide information about the concentration of the ore at different positions.</p> <p>Accept other relevant answers.</p>	

## ACKNOWLEDGEMENTS

- Question 18(a)** Graph adapted from: Bureau of Meteorology. (n.d.). NINO3.4 SST index. Retrieved July, 2019, from <http://www.bom.gov.au/climate/enso/indices.shtml?bookmark=nino3.4>  
Used under Creative Commons Attribution 3.0 Australia licence
- Question 20(b)** Extract from: SBM Crushers. (n.d.). Hydrated lime manufacturing process: *Process description*. Retrieved September, 2019, from [www.unsalarhotel.com/solution/hydrated-lime-manufacturing-process.html](http://www.unsalarhotel.com/solution/hydrated-lime-manufacturing-process.html)
- Question 20(c)** Infographic adapted from: CO2CRC. (n.d.). *Enhanced greenhouse effect*. Retrieved September, 2019, from <http://www.co2crc.com.au/gallery/general-ccs/>

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