STUDENT GUIDE

NEW EDITION

With exam-style questions and model answers

PEARSON EDEXCEL A-LEVEL

Geography

Physical geography

- Tectonic processes and hazards
- Landscape systems, processes and change (Glaciated landscapes and change; Coastal landscapes and change)
- The water cycle and water insecurity
- The carbon cycle and energy security

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Content Guidance

This section outlines the following areas of the AS geography and A-level geography specifications:

- Tectonic processes and hazards
- Landscape systems, processes and change
  - Glaciated landscapes and change
  - Coastal landscapes and change
- The water cycle and water insecurity
- The carbon cycle and energy security

Read through the topic area before attempting a question from the Questions and Answers section.

Tectonic processes and hazards

Why are some locations more at risk from tectonic hazards?

- Tectonic hazards (earthquakes, volcanic eruptions and tsunami) occur in specific locations, related to tectonic plate boundaries and other tectonic settings.
- Their distribution is uneven, with some areas at high risk and other locations at no risk.
- Tectonic events can generate multiple hazards when they occur.

The global distribution of tectonic hazards

All tectonic hazards are caused by the Earth's internal heat engine. Radioactive decay of isotopes such as uranium-238 and thorium-232 in the Earth's core and **mantle** generate huge amounts of heat which flow towards the Earth's surface. This heat flow generates convection currents in the plastic mantle. The interior of the Earth is therefore dynamic rather than static. Most tectonic hazards occur at or near tectonic plate boundaries. These represent the locations of ascending (divergent plate boundaries) and descending (convergent plate boundaries) arms of mantle convection cells (Figure 1).

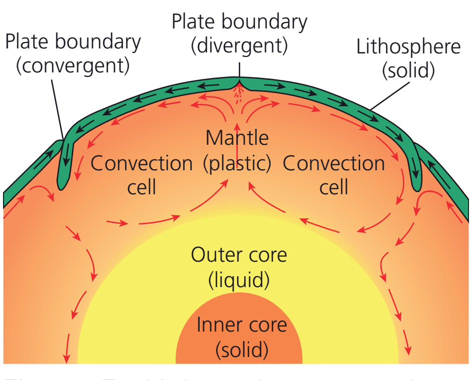

Figure 1 Earth's internal structure and mantle convection

Exam tip

All tectonic hazards are physical events, with natural causes. Only use the word 'disaster' when referring to the impact of these events on people.

Exam tip

The terms 'plate boundary' and 'plate margin' are used interchangeably. They both mean the narrow, linear zone where two tectonic plates meet.

The **mantle** is a solid, but because of the very high temperatures present it is locally deformable (plastic) and capable of very slow 'flow'.

Figure 2 shows the distribution of earthquakes, volcanoes and tectonic plate boundaries. Most earthquakes occur at, or close to, these boundaries. This is also true of volcanic eruptions. Some plate boundary earthquakes cause a secondary tectonic hazard, tsunami.

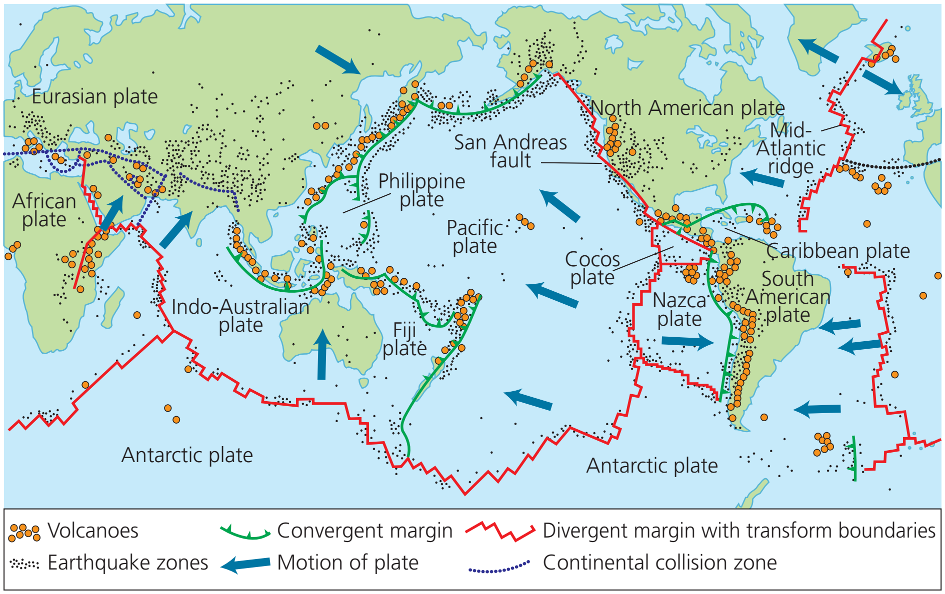

Figure 2 The global distribution of plate boundaries, earthquakes and volcanoes

Not all tectonic plate boundaries are the same and this has an important impact on the type and magnitude of tectonic hazards. Plate boundary type depends on two factors:

1. Motion: whether plates are moving apart (divergent), colliding (convergent) or sliding past each other (conservative or transform).
2. Plate type: whether the tectonic plates are oceanic or continental. Oceanic plates make up the ocean floor and are high-density, basaltic rock but only 7–10 km thick. Continental plates make up Earth's landmasses and are much thicker at 25–70 km but made of less dense granitic rock.

This combination of motion and plate type causes the different plate boundary types that are summarised in Table 1 on p. 8.

Although the vast majority of earthquakes and eruptions occur at plate boundaries, a small number do not. Some volcanic eruptions are described as 'intra-plate'. This means they are distant from a plate boundary at locations called mid-plate hotspots (such as Hawaii and the Galapagos Islands). At these locations:

- isolated plumes of convecting heat, called **mantle plumes**, rise towards the surface, generating basaltic volcanoes that tend to erupt continually
- a mantle plume is stationary, but the tectonic plate above moves slowly over it
- over millennia, this produces a chain of volcanic islands, with extinct ones most distant from the plume location.

Mantle plumes are concentrated areas of heat convection. At plate boundaries they are sheet-like, whereas at hot spots they are column-like.

Tectonic processes and hazards

Question 1

(a) Study Figure 1. For each location shown in Figure 1, calculate the tsunami travel time from the origin to the location. (4 marks)

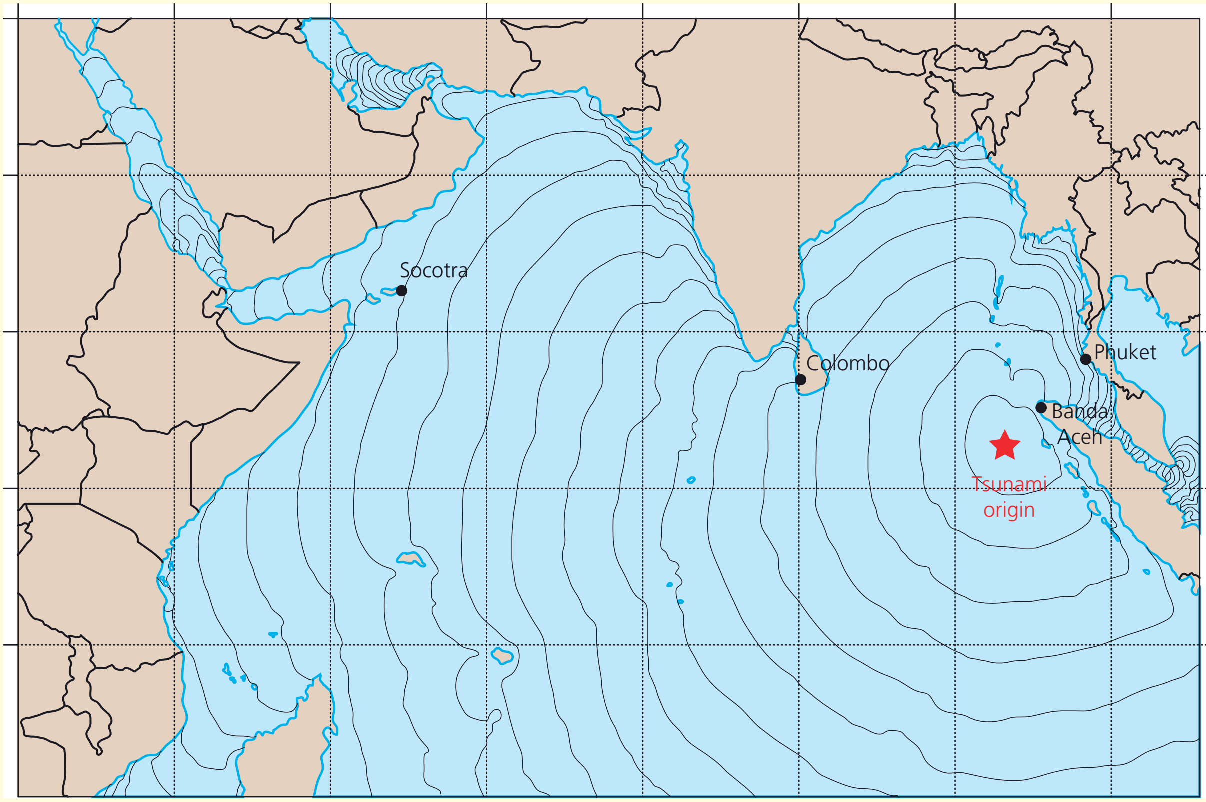

Figure 1 Tsunami travel-time contours at 30-minute intervals

(b) Assess the importance of prediction and forecasting in the successful management of tectonic disasters. (12 marks)

Part (a) is a skills question, using the information on Figure 1. The key here is to be accurate and to recognise that the isolines on Figure 1 are in 30-minute, not 1-hour, intervals. Don't rush these skills or 'doing' questions as mistakes are easy to make.

Part (b) is an extended writing question that is marked in levels. 'Assess the importance' means 'weighing up', so your answer needs to be evaluative in style. Both prediction and forecasting need to be mentioned, and high-quality answers will also consider other factors such as response and evacuation, as prediction and forecasting are not the only factors that determine whether tectonic disasters are successfully managed. Use examples to support your answer to give it the required depth. The levels mark scheme for 12-mark questions is shown below.

Level 1 1–4 marks	■ Demonstrates isolated elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant ■ Applies knowledge and understanding of geographical information/ideas, making limited logical connections/relationships ■ Applies knowledge and understanding of geographical information/ideas to produce an interpretation with limited relevance and/or support ■ Applies knowledge and understanding of geographical information/ideas to make unsupported or generic judgements about the significance of few factors, leading to an argument that is unbalanced or lacks coherence
Level 2 5–8 marks	■ Demonstrates geographical knowledge and understanding which are mostly relevant and may include some inaccuracies ■ Applies knowledge and understanding of geographical information/ideas logically, making some relevant connections/relationships ■ Applies knowledge and understanding of geographical information/ideas to produce a partial but coherent interpretation that is mostly relevant and supported by evidence ■ Applies knowledge and understanding of geographical information/ideas to make judgements about the significance of some factors, to produce an argument that may be unbalanced or partially coherent
Level 3 9–12 marks	■ Demonstrates accurate and relevant geographical knowledge and understanding throughout ■ Applies knowledge and understanding of geographical information/ideas logically, making relevant connections/relationships ■ Applies knowledge and understanding of geographical information/ideas to produce a full and coherent interpretation that is relevant and supported by evidence ■ Applies knowledge and understanding of geographical information/ideas to make supported judgements about the significance of factors throughout the response, leading to a balanced and coherent argument

Student answer

(a)

	Tsunami travel time	
Location	Hours	Minutes
Banda Aceh	1	30
Colombo	2	30
Phuket	2	30
Socotra	6	30

4/4 marks awarded. Part (a) scores 4 marks as all of the answers are accurate. There is some leeway in the minutes but not the hours.

(b) Prediction means the ability to say when and where a hazard will strike. For prediction to be useful it has to be accurate to within a few days, otherwise evacuations based on predictions become lengthy and problematic. Forecasting means giving the percentage chance of a hazard occurring ✓. For earthquakes, forecasting is possible ✓. For instance, the USGS forecasts that many California locations have a 10% chance of a 6.7 earthquake in the next 30 years ✓. This type of forecast quantifies risk, so is useful for people buying homes or for emergency services planning for a disaster. Earthquakes cannot be predicted, so prediction is of no use. Far more important is preparation and public education so people know what to do during and after an earthquake. Land-use zoning can be used to avoid building in areas of high risk, e.g. risk of liquefaction, and this can reduce economic and human losses. In contrast, volcanic eruptions can increasingly be predicted using gas spectrometers, tiltmeters and by analysing the seismic 'noise' made by mobile magma ✓. This allows for timely warning and evacuation. For instance 10,000s of people were saved by the timely evacuation around Mt Pinatubo when it erupted in 1991 ✓. However, monitoring volcanoes is costly and not done in all cases. This means that education, preparation and response should a disaster occur are important ✓. Technology such as ocean monitoring buoys can be used to predict the arrival of tsunami ✓, and even 5–10 minutes' warning can save large numbers of lives. However, it cannot prevent very high economic losses such as the US$150 billion in losses caused by the 2011 Sendai tsunami in Japan ✓. In conclusion, prediction is very important for eruptions and tsunami, but only forecasting is possible for earthquakes ✓. In all cases, prediction and forecasting tend to reduce human losses. Reducing economic loss depends more on long preparation and response.

12/12 marks awarded. The answer to part (b) is very good and scores 12 marks. It is well structured and uses good terminology. It shows a good understanding of both forecasting and prediction, recognising them as different things. There are examples used to support the answer, which provides depth. The answer is applied to volcanoes, earthquakes and tsunami so a good range of hazards is considered. The value of prediction is considered and judgements are made contrasting the case of volcanoes versus earthquakes. There is also assessment by considering that even though prediction is useful for eruptions, it is not available everywhere, meaning that other factors are important if disasters are to be successfully managed.

Question 2

(a) Study Table 1.

Table 1 Volcanic eruptions and death tolls in Indonesia

Death toll	Volcano name	Eruption date
5000	Kelud	1919
1584	Mount Agung	1963
1369	Mount Merapi	1930
426	Anak Krakatoa	2018
353	Mount Merapi	2010
18	Galunggung	1982
16	Sinabung	2014
7	Sinabung	2016
2	Kelud	2014
2	Mount Bromo	2004
Summary of data		
Number of eruptions	10	
Total death toll	8,777	