3.4 Option: Geophysical hazards

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS plate margin • constructive margin • destructive margin • conservative margin • hazard risk • exposure • vulnerability • epicentre

Objective

Build the skills to answer Paper 1 questions on the **geophysical hazards** option: **plate margins**, volcanoes, earthquakes, tsunamis and mass movement, the **hazard risk** equation, why similar events have very different effects, and how people predict, prepare and respond.

You must be able to:

- explain the hazards at constructive, destructive and conservative margins
- explain why some volcanoes are explosive
- use the magnitude scale to compare the energy of earthquakes
- explain hazard risk with hazard, exposure and vulnerability
- compare the effects of two earthquakes in places at different levels of development
- evaluate prediction, preparation and response

1 Key knowledge and worked examples

■ Plates and hazards

margin	movement	hazards	example
constructive	plates move apart	runny (basaltic) lava, gentle volcanoes, small earthquakes	Iceland
destructive	one plate sinks under another	sticky, gas-rich (andesitic) magma → explosive volcanoes; large earthquakes; tsunamis	Japan
conservative	plates slide past each other	earthquakes	California

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Earthquake **magnitude** is measured on a log scale: each whole number up releases about **32 times** more energy, so 2 numbers up $\approx 32 \times 32 \approx 1{,}000$ times. Shaking also starts landslides (**mass movement**), especially on steep, wet slopes.

■ Risk

$$\text{risk} = \text{hazard} \times \text{exposure} \times \text{vulnerability}$$

Exposure: how many people and buildings are in the hazard's path. **Vulnerability**: how easily they are harmed (poverty, weak buildings, poor warnings).

	Haiti, 2010	Tōhoku, Japan, 2011
magnitude	7.0	9.0 (about 1,000 times more energy)
deaths	more than 100,000	about 18,000 dead or missing, mostly from the tsunami
why	weak buildings; the capital close to the epicentre; weak government	strict building codes, warnings and drills; but the tsunami was higher than many sea walls

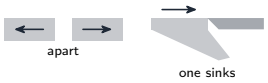
■ Management

The **hazard management cycle**: mitigation (building codes, land-use zoning) → preparation (drills, warning systems, emergency kits) → response (rescue, shelter) → recovery (rebuilding). Volcanoes can often be predicted from gas, ground swelling and small earthquakes; earthquakes cannot be predicted, but warning systems can give seconds of notice.

Worked example. M8.0 compared with M6.0: $32 \times 32 \approx 1{,}000$ times more energy.

2 Practice

2.1 State **two** differences between a constructive and a destructive plate margin. [2]

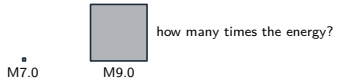


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2.2 The 2011 Tōhoku earthquake had a magnitude of 9.0, and the 2010 Haiti earthquake 7.0. Each step of 1 on the scale is about 32 times more energy. Calculate how many times more energy the Tōhoku earthquake released, and explain why Haiti still had more deaths. [3]

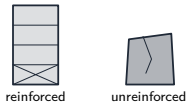


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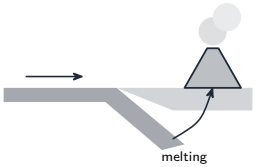
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2.3 State **two** factors that increase people's vulnerability to earthquakes. [2]



2.4 Explain why volcanoes at destructive margins are often explosive. [3]



2.5 Explain **two** ways in which Japan prepares for earthquakes and tsunamis. [4]



3 Exam-style questions

3.1 *(Paper 1 style.)* The table compares two earthquakes.

(a) Using the table, identify **two** differences that help to explain the different death tolls. [2]

(b) Explain why most deaths in Japan in 2011 were caused by the tsunami, not the shaking. [4]

	Haiti, 2010	Japan, 2011
magnitude	7.0	9.0
deaths (dead or missing)	more than 100,000	about 18,000
main cause of death	collapsed buildings	tsunami
building codes enforced	rarely	strictly
warnings and drills	few	regular

3.2 "The level of development is the most important factor in the impact of a geophysical hazard." To what extent do you agree? [10]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

any two: constructive: plates move apart; destructive: one plate sinks under another; constructive: runny lava and gentle volcanoes; destructive: explosive volcanoes; constructive: small earthquakes; destructive: large earthquakes and tsunamis

2.2

$32 \times 32 \approx$ **1,000** times; Haiti's buildings were weak and the capital was close to the epicentre; Japan has strict building codes, warnings and drills, so its vulnerability is lower

2.3

any two: poverty; weak buildings without building codes; no warning system or drills; a weak government or poor emergency services; living on steep slopes where landslides happen

2.4

the sinking plate melts and forms magma rich in silica (andesitic); this magma is sticky (viscous), so gas cannot escape easily; pressure builds until the gas escapes violently, an explosive eruption

2.5

any two, explained: strict building codes, e.g. deep foundations and shock absorbers, so buildings bend instead of collapsing; an earthquake early-warning system that stops trains and warns people seconds before strong shaking; drills in schools and workplaces every year, so people know what to do; sea walls and marked evacuation routes for tsunamis, so people can reach high ground

3.1

(a) any two: Haiti had weak buildings and no building code enforced, Japan strict codes; Haiti's capital was close to the epicentre; Japan had warnings and drills, Haiti did not; Japan's GDP per person was far higher, so it could afford preparation

(b) Japanese buildings are built to resist shaking, so few collapsed; the earthquake was under the sea at a destructive margin, so it pushed up the sea floor and made a tsunami; the tsunami was higher than many sea walls, so it flooded coastal towns; people had only minutes to escape, and some did not reach high ground

3.2

Mark with the markbands: [9-10] focused on the command term, detailed and accurate knowledge, well-developed explanation, specific named examples (places, dates, numbers), balanced evaluation and a supported conclusion; [7-8] mostly focused, good knowledge and examples, some evaluation; [5-6] relevant knowledge and examples, explanation partly developed, little evaluation; [3-4] general knowledge, few examples, mostly description; [1-2] little that is relevant. Points that may be included: development matters: Haiti 2010 killed more than 100,000; Japan 2011 far fewer from the shaking, because of building codes and drills; rich countries can afford warning systems, strong buildings and quick rescue; poor countries often have informal housing and weak governments, which raise vulnerability; but the hazard itself matters: the Tōhoku tsunami killed about 18,000 even in a very developed country; exposure matters: a quake near a big city kills more than one in an empty area; time of day and type of hazard: night-time quakes catch people in bed; tsunamis and landslides kill differently from shaking; governance and corruption: building codes only help if enforced; developing countries can lower deaths cheaply, e.g. Bangladesh's cyclone warnings show low-cost preparation works; conclusion: development is very important because it shapes vulnerability, but the size and type of hazard and the exposure also decide the impact

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