GEO.PH18 Reducing Tectonic Hazard Risk: Monitoring, Prediction, Protection, Planning

Total Marks

AQA 8035 · Calculators not allowed · about 45 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Give one example of a monitoring instrument used to detect signs of volcanic unrest.

(Total for Question 1 is 1 mark)

2 State what is meant by a seismometer when used in earthquake monitoring.

(Total for Question 2 is 2 marks)

3 Name TWO protective design features that can make buildings more resistant to earthquake shaking.

(Total for Question 3 is 2 marks)

4 Describe how a tiltmeter helps scientists monitor a volcano and how this reduces hazard risk.

(Total for Question 4 is 3 marks)

5 Explain how automated gas-emission sensors (measuring gases such as sulphur dioxide) can be used to predict volcanic eruptions. Give TWO linked points.

(Total for Question 5 is 4 marks)

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6 Describe how a seismometer helps in earthquake monitoring and how that monitoring reduces the effects of an earthquake for people in affected areas.

(Total for Question 6 is 3 marks)

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7 Describe how GPS ground-deformation sensors help scientists monitor tectonic activity and how this reduces hazard risk for communities near active faults or volcanoes.

(Total for Question 7 is 3 marks)

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8 Explain how patterns from historical records and statistical analysis can be used to predict future tectonic events. Give up to FOUR linked points.

(Total for Question 8 is 4 marks)

9 Describe how base isolators in building design reduce the effects of earthquake shaking on a structure.

(Total for Question 9 is 3 marks)

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10 Describe how automatic gas shut-off valves reduce secondary hazards during an earthquake.

(Total for Question 10 is 2 marks)

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11 Describe how evacuation routes and regular drills are used as planning strategies to reduce the effects of a volcanic eruption or large earthquake on a local community.

(Total for Question 11 is 3 marks)

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12 Give TWO reasons why a low-income country may have less access to monitoring, prediction and protection strategies for tectonic hazards than a higher-income country.

(Total for Question 12 is 4 marks)

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13 Give one example of a planning measure taken around an active volcano that restricts access to the most dangerous areas.

(Total for Question 13 is 1 mark)

14 Explain why the effectiveness of hazard-reduction strategies such as monitoring, prediction, protection and planning varies between countries with different levels of development.

(Total for Question 14 is 6 marks)

Mark scheme · GEO.PH18 Reducing Tectonic Hazard Risk: Monitoring, Prediction, Protection, Planning

Question 1

- **B1** any one monitoring instrument, e.g. seismometer, tiltmeter, gas-emission sensor (SO2), GPS/ground-deformation sensor, oe
- **Answer: Seismometer (also accept tiltmeter, gas-emission sensor, GPS ground-deformation sensor).**

Question 2

- **B1** an instrument that detects and records ground vibrations/earthquake waves, oe
- **B1** it gives data on the time, strength and location of seismic events, oe
- **Answer: A seismometer is an instrument that detects and records ground vibrations or earthquake waves; it provides data on the time, strength and location of seismic events.**

Question 3

- **B1** one protective design feature, e.g. base isolators, cross-bracing, reinforced concrete frames, shear walls, automatic gas shut-off valves, oe
- **B1** a second distinct protective design feature, oe
- **Answer: For example, base isolators and cross-bracing (also accept reinforced frames, shear walls, automatic gas shut-off valves).**

Question 4

- **B1** it measures small changes in the slope or tilt of the ground around a volcano, oe
- **B1** ground tilt often indicates magma moving underground and the volcano inflating, oe
- **B1** detecting inflation early gives time for warnings/evacuations, reducing risk to people, oe
- **Answer: A tiltmeter measures small changes in the slope or tilt of the ground around a volcano; ground tilt often indicates magma movement and inflation beneath the surface, so detecting this early allows authorities to issue warnings and organise evacuations, reducing risk to people.**

Question 5

- **B1** gas sensors measure increases or changes in volcanic gases such as SO2, CO2, oe
- **B1** a rise in gas emissions can indicate magma is nearing the surface or rock is fracturing, oe
- **B1** this information can be combined with other monitoring data to forecast an eruption, oe
- **B1** a forecast allows officials to prepare or evacuate people, reducing casualties and disruption, oe
- **Answer: Gas-emission sensors record increases or changes in gases such as SO2 and CO2; a rise in emissions can indicate magma is rising or rock is fracturing, and combined with other monitoring data this helps scientists forecast an eruption so officials can prepare or evacuate people, reducing casualties.**

Question 6

- **B1** it detects and records ground vibrations and seismic waves, giving data on when and where small quakes occur, oe
- **B1** networked seismometers can show increasing seismic activity or foreshocks, indicating a higher chance of a larger quake, oe
- **B1** this monitoring gives early warning of increased risk so authorities can raise alert levels, shut down transport or gas systems and implement emergency plans, reducing harm, oe
- **Answer: A seismometer detects and records ground vibrations and seismic waves, providing data on when and where small quakes occur; networks of seismometers can reveal increasing activity or foreshocks, indicating higher risk, and this allows authorities to raise alerts, shut down vulnerable services and activate emergency plans, reducing harm to people.**

Question 7

- **B1** GPS sensors measure small movements and deformation of the Earth's surface over time, oe
- **B1** ground deformation can indicate stress build-up on faults or magma movement under a volcano, oe
- **B1** detecting deformation allows scientists to warn authorities and plan evacuations or close hazardous areas, reducing risk to communities, oe
- **Answer: GPS sensors measure small movements and deformation of the Earth's surface; such deformation can indicate stress build-up on faults or magma movement beneath a volcano, so detecting it allows scientists to warn authorities and plan evacuations or area closures, reducing risk to communities.**

Question 8

- **B1** historical records show timing and frequency of past earthquakes or eruptions in an area, oe
- **B1** statistical analysis of recurrence intervals can estimate the probability of another event in a given time period, oe
- **B1** combining past patterns with current monitoring increases confidence in short-term forecasts or risk assessments, oe
- **B1** these probability-based predictions allow planners to set building standards, land-use policies and preparedness levels for likely times or zones, reducing impacts, oe
- **Answer: Historical records provide data on timing and frequency of past earthquakes or eruptions; statistical analysis of recurrence intervals estimates the probability of another event in a time period. Combined with current monitoring, this improves forecasts and risk assessments, allowing planners to set building standards, land-use policies and preparedness levels for likely times or zones, reducing impacts.**

Question 9

- **B1** base isolators are placed between a building's foundation and its superstructure to decouple movement, oe
- **B1** they absorb or reduce the energy transferred from ground shaking into the building, ie they limit movement of the structure, oe
- **B1** this reduces structural damage and the risk of collapse, protecting occupants and contents, oe
- **Answer: Base isolators are fitted between a building's foundation and superstructure to decouple ground motion from the building; they absorb or reduce energy transferred during shaking, limiting structural movement and reducing damage and collapse risk, protecting occupants.**

Question 10

- **B1** automatic valves detect strong shaking and close gas supply pipes, oe
- **B1** this prevents gas leaks and reduces the risk of fires and explosions after a quake, protecting people and property, oe
- **Answer: Automatic gas shut-off valves detect strong shaking and close gas supply pipes, preventing leaks and reducing the risk of fires and explosions after an earthquake, thus protecting people and property.**

Question 11

- **B1** evacuation routes provide pre-planned, signposted paths for people to leave danger zones quickly, oe
- **B1** regular drills familiarise the community with what to do and where to go, reducing panic and evacuation time, oe
- **B1** together these measures speed up safe movement out of harm's way and reduce casualties, oe
- **Answer: Evacuation routes provide pre-planned, signposted paths for people to leave danger zones quickly; regular drills familiarise the community with actions and routes, reducing panic and evacuation time. Together they speed safe movement out of harm's way and reduce casualties.**

Question 12

- **B1** reason 1, e.g. limited financial resources to buy and maintain instruments, high-tech equipment and trained staff, oe
- **B1** linked detail for reason 1, e.g. without funding and maintenance, monitoring networks may be sparse or unreliable, reducing prediction ability, oe
- **B1** reason 2, e.g. weaker institutional capacity and technical expertise to plan and enforce protective building codes, oe
- **B1** linked detail for reason 2, e.g. even if designs exist, lack of enforcement and affordable construction means many buildings remain vulnerable, oe
- **Answer: Limited financial resources to buy, maintain and staff monitoring equipment, which can leave networks sparse or unreliable; and weaker institutional capacity and technical expertise to plan, enforce and fund protective building codes, so many buildings remain vulnerable.**

Question 13

- **B1** any one correct example, e.g. an exclusion zone around the crater, temporary no-go zones, restricted access to valleys at risk from lahars, oe
- **Answer: An exclusion zone around the crater (also accept temporary no-go zones or restricted access to valleys at risk from lahars).**

Question 14

- **Level 3** (5-6): A clear, well-developed explanation that links differences in resources, technology, governance and public awareness to variation in the effectiveness of monitoring, prediction, protection and planning, with supporting examples or reasoning and a clear overall judgement.
- **Level 2** (3-4): A reasonable explanation that describes several relevant factors, such as money, expertise or enforcement, and makes some links to how they affect effectiveness, with limited supporting detail.
- **Level 1** (1-2): One or two simple points about why strategies vary in effectiveness, stated without development or clear links to outcomes.
- **Indicative content:**
  - Availability of finance, since monitoring networks, protective technologies and resilient infrastructure require investment; wealthier countries can usually afford denser monitoring networks and better-protected buildings.
  - Technical expertise and trained personnel, because instruments need skilled staff to operate, maintain and interpret data, and building designs require engineers and inspectors to implement and enforce standards.
  - Institutional capacity and governance, as effective planning and enforcement of building codes, land-use zoning and evacuation plans depend on functioning institutions and low corruption.
  - Public awareness and education, since regular drills, community knowledge of evacuation routes and willingness to evacuate depend on public engagement and trust in authorities.
  - Access to technology and supply chains, because some protective measures need specialised materials and manufacturing (e.g. base isolators) which may be unavailable or unaffordable in poorer countries.
  - Trade-offs and priorities, where low-income countries may prioritise immediate needs such as healthcare and food over long-term hazard investment, reducing application of some strategies.
  - A balanced conclusion might judge that development level is a major factor but that political will, international aid, local knowledge and low-cost measures can still improve effectiveness in less wealthy countries.