21st International Geography Olympiad

Bangkok, Thailand

26 July – 1 August 2025

WRITTEN RESPONSE TEST

Marking Scheme

Instructions for Markers

1. **Check if the iGeo student numbers are on each sheet (on odd pages) before dividing up the Test**.

2. This test consists of 6 sections.

3. The maximum total mark is 90.
   The mark for each question is given in the margin at the beginning of the question.
   There is a maximum of 15 marks for each section.

4. One whole section will be assigned to a pair of markers.
   Some lengthy (more than 2 pages) sections may be divided for two marker-pairs.

5. Get the hang of the full range of answers by reading through a few papers with your co-marker before you start your marking.
   You can mark together (especially for level marking), or after establishing a consensus on how to mark for thoroughness and consistency, act as each other's double-checkers by marking half of the test and then swapping the pile.
   We strongly recommend whenever in doubt, consult your marking partner and, if appropriate, the designated moderator(s).

6. Please develop your own marking/correcting notation system (using +/-, x/0, √ marks), underlining, comments etc. to ease double-checking and sample marking.

7. **These answers here are not exhaustive. Credit any relevant answer.**

8. Check whether the answer continues outside the designated area, in the margins or as clearly marked on blank pages.
   No credits will be given to answers in the Resource Booklet.

9. The test uses two marking systems: point and level marking.

10. Half marks can only be given where indicated as the total of 90 marks will yield only 40% of the total Olympiad result.

11. Mark only the required number of answers (reasons, examples etc.).
    For instance, if the question asks for 2 reasons and there is more than 2, only the first 2 reasons should be marked.

12. Put your final mark next to the question number in the column on the left – it eases the work of the person who has to put the numbers into MS Excel.
    Please write your numbers clearly.

13. Please write down any inconsistencies of the Marking Scheme, revisions and additional answers or answers not accepted on the Notes page at the end of the Booklet (e-mail is preferred) and hand them in after marking to improve the final Marking Scheme that will be uploaded to show the actual marking.

14. The moderator(s) will sample the marking of all teams.

Command Terms for use in Written Response Test

Terms	Meaning
Analyse	break down the content of a topic, or issue, into its constituent parts in order to provide an account of it
Annotate	add labels with short comments to a diagram, map or photograph in order to describe or explain
Describe	give a factual statement of the distinctive features of something, e.g. for a landform, its shape, dimensions, composition, location (do not explain)
Discuss	give a thorough account from different points of view
Draw	make a clearly defined diagram, flowchart or map, and include labels
Elaborate	give further detail
Estimate	approximately calculate the number
Explain	give a reason, a cause, an effect, a consequence for why or how something happens
Evaluate	consider several arguments or options and come to a conclusion about their importance or success
Forecast	predict or estimate (a future event or trend)
Identify	name, select, point out something
Justify	provide sound reasons or evidence on which your response is based
Label	add names to a map, diagram, sketch or table
Match	put something together with something else that is appropriate or related
Name	state or specify, using a word or words by which something is known
Outline	give the main points or general principles of something, omitting minor details, and usually emphasizing structure and relationships
Specify	identify clearly
Study	look closely at the details in
Suggest	put forward an idea or a reason
With the help of the information provided	base answer partly on information provided (refer to this material) and partly on own knowledge

In level marking in order to credit higher marks the response has to cover a multi-perspective view with a range of factors/impacts from different spatial and temporal scales forming a thorough and well-elaborated account.

Section A: Landslides

Resource Booklet Figure A1 represents a diagram of anticlines and synclines.
Resource Booklet Figure A2 shows the remnants of a landslide that took place in La Conchita, California, USA (January 2005). Ten people were killed.

1 m

1. Name **two natural forces** that can trigger landslides.

Point marking.

Suggested answers (award **two** of the answers listed):
- Precipitation (rainfall and snowmelt)
- Flooding gravity
- Weathering along rock face fissures
- Changes in water level
- Stream erosion
- Changes in ground water
- Waves
- Earthquakes
- Volcanic activity

Award **0.5 mark** for each correct answer.
Award a maximum of 2 listed answers.

Accept any other relevant and complete answer.

2 m

2. Identify and explain **two specific human activities** that may contribute to landslides.

Point marking.

Suggested answers **must have an explanation** on how the activity contributes to landslides:
- Building roads or structures on steep slopes – adds weight and pressure to a slope and without adequate grading, the slope can become unstable.
- Deforestation or removal of ground cover vegetation – causes the loss of root systems holding the soil in place and/or accelerated surface runoff of precipitation.
- Digging/undercutting at the bottom of slopes – can release pressure and lead to bedding plain fracturing.
- Disturbing old landslides – creates instability in an already landslide prone area.
- Poorly planned alteration of drainage patterns – may cause an increased pooling of water and lead to slope instability and/or liquification issues.
- Nuclear explosions.

Award a maximum of two activities.
Award **1 mark** for each identified **and** explained human activity.
Award **0.5 mark** for each identified human activity **without** an explanation.

Accept any other relevant and complete answer.

3. **For this question, refer to Resource Booklet: Figure A1.**

0.5 m a) Specify the location on the diagram that is **most susceptible** to landslide activity (A, B, C or D).

Point marking.

Suggested Answer: D

Award **0.5 mark** for identifying this location.

1 m b) Explain the reason for the location selected above (in 3a).

Point marking.

Suggested answer:

- Location D has the steepest slope exposed to rainfall run-off, gravity, bedding plain fracturing.

Award **1 mark** for a complete answer that contains at least the suggested elements.
Award **0.5 mark** for a partial answer.

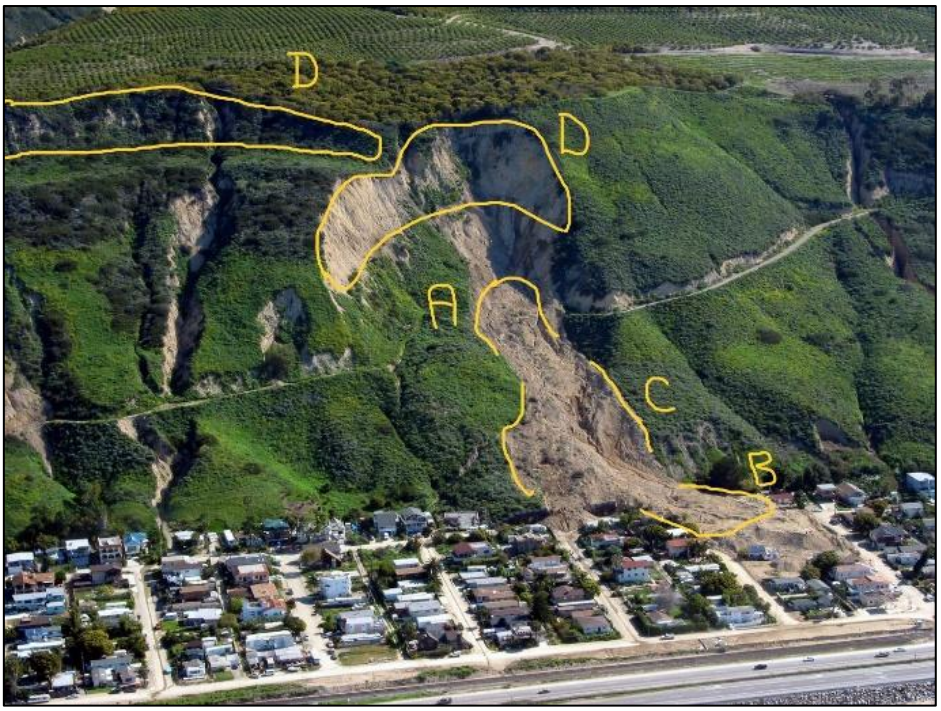
Accept any other relevant and complete answer.

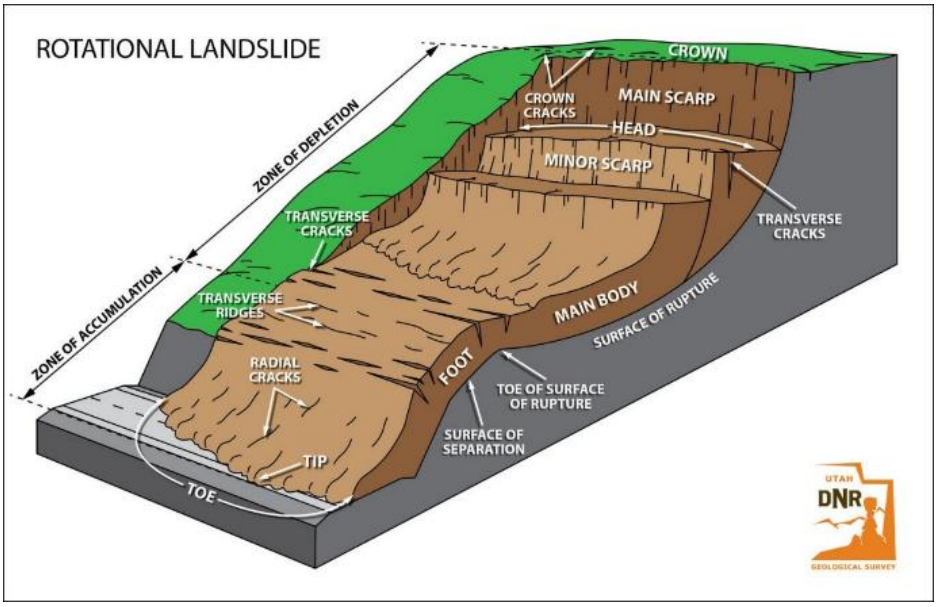
4. **For this question, refer to Resource Booklet: Figure A2.**

2 m a) Clearly label the **parts of a landslide** on Figure A2 below, using the following letters as labels: A: head, B: foot, C: surface of rupture, D: scarp surface.

Point marking.

Suggested answers are shown on the image as well as a diagram for marker reference.





Note that D (scarp) could have two areas. The scarp location on the left of the image is from a previous landslide.

Award a maximum of **2 marks** for all parts of the landslide labelled correctly.
Award **0.5 mark** for each correctly labeled part of a landslide.

2 m b) Identify specific evidence from Figure A2 that indicates a previous landslide took place in the area.

Point marking.

Suggested answers:
- There is an old scarp visible in the top left of the photograph
- Scree fans at the bottom of the banks (now covered by vegetation)
- Areas of slumping below the old scarp
- Small landslide area below the slumping and above the road.

Award **1 mark** for each correctly identified feature that includes specific reference to the photograph.
Award **0.5 mark** for an answer that does not reference the photograph.

Accept any other relevant and complete answer.

4 m c) Suggest two actions that can be taken to **protect** the neighbourhood from future landslides and **evaluate the effectiveness** of each measure that you provide.

Point marking.

Suggested answers:

Actions:
- Anchors and drainage prevention by planting trees and other forms of vegetation (certain grasses and shrubs to break rainfall, slow surface runoff and absorb groundwater)
- Protection by building a containment channel or interceptor drains
- Avoidance by selecting an alternative location for settlement
- Protection by installing netting
- Monitor the slope for signs of movement
- Protection by building safety walls

Effectiveness of the Action:
- Student assessment of the effectiveness will vary.
- Accept any relevant and correct answer that relates directly to the action they provided.

Award a maximum of **2 marks** for each identified and evaluated actions.
Award **1 mark** for identifying an action to protect the neighbourhood.
Award **1 mark** for a thorough explanation of the effectiveness of the action identified.
Award a maximum of two actions.

5. After wildfires occur in mountainous areas, there is an increased danger of landslides occurring.

0.5 m a) Name the **season** when post wildfire landslides are most likely to occur.

Point marking.

Suggested answer: late winter/early spring **OR** spring

Award **0.5 mark** for correctly identifying the season.

2 m

b) Explain why landslides are more likely to occur during the season you selected.

Point marking.

Suggested answers:

- Freezing temperatures in the late winter can cause water in the soil to freeze and expand, increasing soil porosity. When the ice thaws, the water can easily infiltrate the loosened soil, further saturating it.
- Saturated soil, especially after periods of freezing and thawing, becomes unstable and more susceptible to the force of gravity, leading to landslides.
- Combination of snowmelt and rainfall in spring is likely to saturate soil, increase the weight of the soil and can also increase pore water pressure making it vulnerable to slips and surface runoff could accelerate erosion – the slope is less stable and more prone to sliding.
- Increased precipitation – heavy rainfall would run on the surface with less infiltrating the ground.
- Reduced vegetation: less trees, ground cover vegetation and root systems to stabilize and hold soil in place and anchor the soil. In late winter and early spring, before vegetation fully leafs out, this stabilizing effect is reduced, making slopes more vulnerable.
- Wildfires damage the forest canopy, as well as the smaller plants and soil below the trees. This can result in increased runoff after intense rainfall or a rapid snowmelt.
- Water cannot soak into dry, fire-altered soils quickly therefore high rainfall amounts will run off the surface and may cause flows.
- During the fall and winter, the amount of precipitation is higher, thus leading to an increased likelihood of a landslide event on steep slopes.
- If there is a high accumulation of snow, the weight of it could also contribute to landslide activity.

Award **2 marks** for a complete answer that contains a **reference to wildfires and seasonal precipitation.**
Award **1 mark** for an answer that contains only one suggested element or listed reason **without explanation**.

Accept any other relevant and correct answer.

Section B: Waves and coastline

Resource Booklet Figure B1 shows a fictional coastline.

2 m

1. Explain the **energy relationship** between wind and the formation of waves.

Point marking.

Suggested answers:
- The strength of the wind – determined by the pressure gradient.
- The duration of the wind – the longer the wind blows, the stronger the waves become.
- The fetch – the distance of open water over which the wind blows. A very long fetch can coincide with the prevailing wind, resulting in very energetic waves.
- The depth – as approaching shoreline, friction with bottom tends to slow base of wave and raise its height

Award a maximum of **2 marks** for two elements.
Award **1 mark** each fully outlined element.
Award **0.5 mark** for each partially outlined element.

Accept any other relevant and complete answer.

4 m

2. Describe four ways **waves change** as they move from deeper water towards the shore.

Point marking.

Suggested answers:
- **Wave shoaling:** In shallow water (water depth less than ½ of the wavelength of the incident wave), the waves begin to experience friction with the sea or ocean floor. This friction causes the wave velocity (celerity) to gradually decrease and thus the wavelength becomes shorter and shorter. As mass and energy must be conserved, the wave height gradually increases as the kinetic energy of the wave motion is converted into the potential energy of the wave height. This process continues until the wave breaks.
- **Wave breaking:** Once the wave reaches a critical height (~1/7 of the wavelength or ~80% of the water depth), the kinetic motion within the wave exceeds its velocity (celerity). This causes the wave to become unstable and break.
- **Refraction of the wave:** In shallow water, the direction in which the wave propagates bends towards areas of shallower bathymetry. This usually means that headlands are more affected by waves than bays, straightening the coastline over time.
- **Wave diffraction:** As waves move past an obstacle such as a breakwater or narrow bay, they propagate into the calm water behind the obstacle. As the energy is conserved, the wave height decreases as the waves propagate into this calm water.
- **Wave reflection:** When waves hit a hard object on the shore before they break, such as a cliff or dyke, the wave is reflected by this object and propagates seaward. Reflected waves interfere constructively and/or destructively with incoming waves.
- **Infragravity waves/edge waves:** Interference between waves and ripples can lead to the formation of long period waves (infragravity waves). In some cases, these waves remain trapped in the nearshore zone and propagate parallel to the coastline. These waves can enhance 3D coastal features such as current channels, 3D bar systems and beach peaks.

Award a maximum of four answers.
Award a maximum **4 marks** for four completely explained changes.

Award a maximum of **1 mark** for four mentioned reasons without explanations.
Award **1 mark** for each completely explained change.
Award **0.5 mark** for each partially explained change.
Note: Students do not need to use the proper terminology for these processes so long as they describe them in a clear manner.

Accept any other relevant and complete answer.

2 m

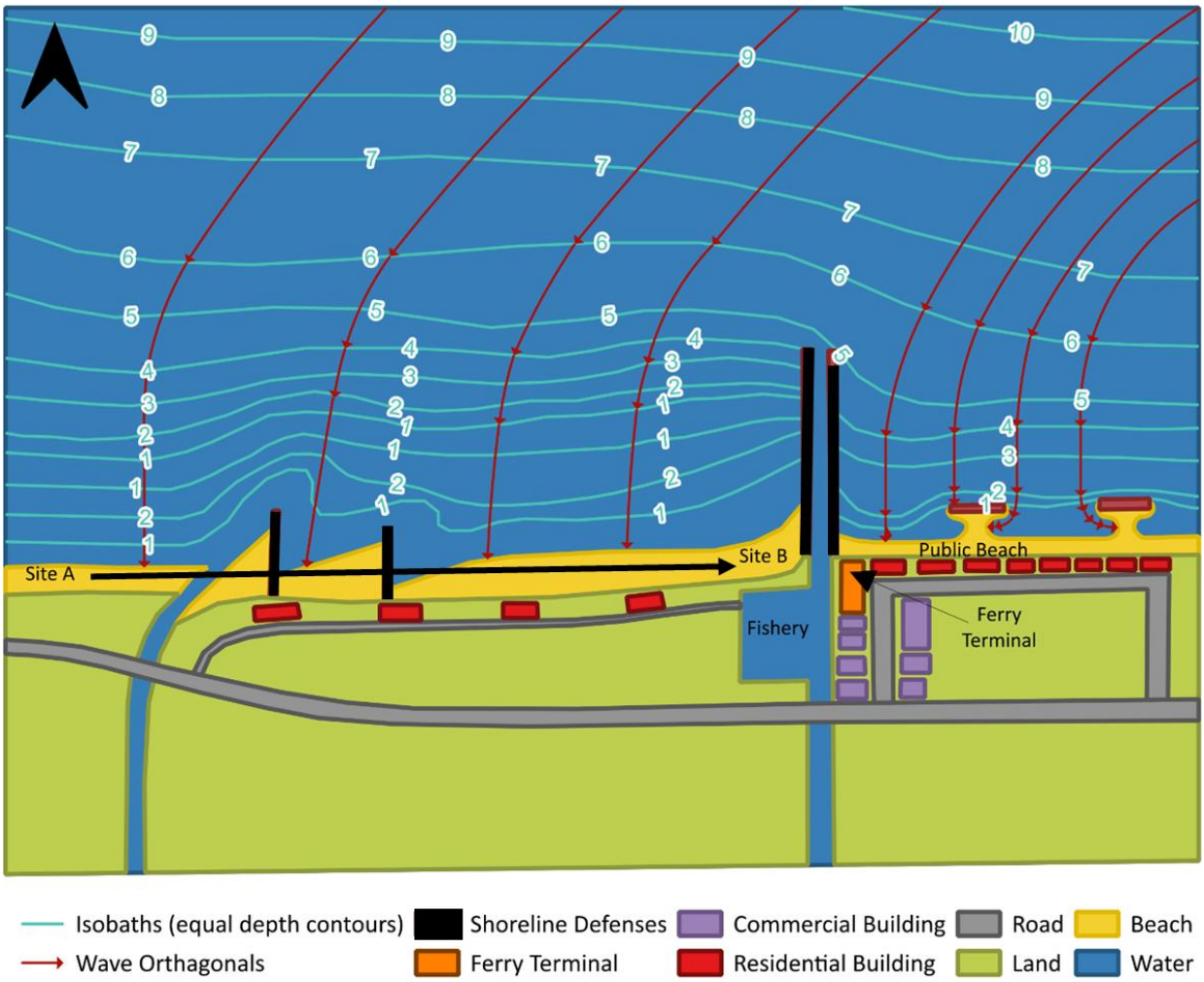
3. Analyse Figure B1. Draw lines representing the **path of the waves** as they move towards the coast. Assume that the waves hit the coast from the north-east and have a wavelength of 14 m. Consider changes to the waves that may occur as they move towards the coast.

Point marking.

Suggested answer – the draw has to include at least four following elements:

- Wave lines remain parallel until the waves begin to “feel" the bottom” at a depth of ½ their wavelength (in this case 7 metres)
- At a depth of less than 7 metres, a general bending of the wave lines in the direction perpendicular to the coastline
- Bending of the wave lines towards the headland and away from the bay (wave breaking)
- Bending of the waves into the entire space within the narrow bay
- Either there are no lines or straight lines landwards of the nearshore bar (beyond the place where the waves break).

Example answer:



Award a maximum of **2 marks** for four correctly drawn elements.
Award **0.5 mark** for each correctly drawn element.

Accept any other relevant and complete answer.

4. **For this question, refer to Figure B1.**

1 m a) Draw an **arrow** on the Figure B1 to identify the direction of the longshore current.

Point marking.

Answer
- From west to east (from A to B)

Award **1 mark** for a correct answer.
Do not award **0.5 mark**.

1 m b) Justify the **reason** for the direction of the arrow you drawn in 4a).

Point marking.

Answer

- The answer has to include a geomorphological evidence (e.g. the river mouth and the sand build-up next to the pier) to justify their answer.

Award **1 mark** for a correct answer.

Accept any other relevant and complete answer.

5 m

5. Use your answers from the previous questions to develop a strategy for shoreline management in this area.

Consider the way in which the various changes will affect the coastline and identify areas where you anticipate erosion and/or sedimentation in the future. You have unlimited resources, so you can build any type of coastal defence and change the land use patterns so long as your suggestions are realistic.

Level marking.
Point marking.

Suggested answer – **part 1 (level marking)**:

- Students can take various approaches to this question, such as building shoreline structures, implementing nature-based solutions (e.g., building artificial oyster reefs, restoring salt marshes), and/or changing land use along the coast, such as controlled retreat in the residential areas with the most erosion. Although solutions may vary, all plans should have these common elements:
    - The plan should take into account the economic, social and environmental aspects of the different coastal areas. As it is very difficult to prevent all erosion, it is often advisable to direct it to less intensively used and ecologically less important areas.
    - If groynes are built, the plan should consider that they will increase erosion in the downstream areas west of the groyne.
    - If dikes are built, the plan should also consider drift-related erosion to the west, a decrease in beach width in front of the dike over time, and the fact that the dike will likely need to be replaced in a 100-year period due to undercutting.
    - Coastal infrastructure, including nature-based solutions, must be suitable for the site. As the area is at 50°N, no mangroves should be planted and the infrastructure must be able to withstand winter ice, at least in the short to medium term.
    - in addition, salt marsh restoration should not occur in areas with steep nearshore bathymetry, as mud erodes quickly in these areas.
    - The best plans for managing coastal areas involve consultation with local people. Local people have a lot of knowledge to share about their coastline.
    - Sometimes less is more. Students may choose to make minimal or no changes to the area, provided they can justify their decision(s) with sound geographical arguments.

Award **3 marks** for a well elaborated answer.
Award **2 marks** for a partially elaborated answer.
Award **1 mark** for a poorly elaborated answer.

Suggested answer – **part 2 (point marking)**:

- The coastal management strategy must identify at least two **impacts of climate change** in the mid-latitudes, e.g. sea level rise, more frequent and intense storms (e.g. hurricanes, cyclones, etc.) and the retreat of winter ice cover.
- Students must also realise that the net effect of these climate change impacts over the next 100 years will lead to **increased erosion** along the coastline, particularly in updrift areas.

Note: Students must use geomorphological evidence (e.g. the river mouth and the sand fill next to the pier) to reach this conclusion. Note that the wave conditions given in question 2 are not typical for this area.

Award a maximum of **2 marks** for both outlined elements.
Award **1 mark** for each fully outlined element.
Award **0.5 mark** for each partially outlined element.

Section C: Water stress

Resource Booklet Figure C1 shows the current water stress by country – freshwater withdrawal as a proportion of available freshwater resources.
Resource Booklet Figure C2 shows the projected water stress in 2050 (ratio of human water demand to water availability).

3 m

1. **For this question, refer to Resource Booklet: Figure C1.**

   Describe the current **spatial distribution** of water scarcity in the world.

   Point marking.

   Suggested answer:
   - **The Middle East and North Africa (MENA)** region is one of the areas with the greatest water shortages. Countries such as Saudi Arabia, Jordan, Kuwait and the United Arab Emirates suffer from critical water shortages.
   - **South Asia** (e.g. India, Pakistan, Bangladesh) is also under great water stress due to rapid population growth, intensive agriculture and water pollution.
   - In **Central Asia** (e.g. Uzbekistan, Turkmenistan), water scarcity is also greater due to the dry climate.
   - In **East Asia, the Philippines and Indonesia**, water stress is slightly higher due to the large population and high economic demand.
   - Parts of the **United States, Mexico** and **South Africa** are also suffering from increasing water shortages, as are certain industrialised European countries (Spain, Italy, Poland…).

   Award a total of **3 marks** for at least three of the above regions. The regions must be ranked in order of water stress (most severe, severe, moderate).
   Award **1 mark** for each region in which certain countries and the degree of water stress are mentioned.
   Award **0.5 mark** for each region in which specific countries are named or for the degree. of water stress.
   A total of **1 mark** for three regions without mentioning countries and water stress

   Accept any other relevant and correct answer.

3 m

2. Identify and explain three **main causes** of high water stress.

   Point marking.

   Suggested answers:
   - **Low annual precipitation combined with high evaporation rates:** In arid and semi-arid regions such as North Africa and the Middle East, rainfall is low, while high temperatures lead to rapid evaporation of surface water.
   - **Excessive extraction of groundwater:** Countries such as India and China are heavily dependent on groundwater for agriculture, which means that aquifers are depleted faster than they can be replenished. Urbanisation, in particular, places a great strain on water resources.
   - **Population growth:** The growing number of people leads to an increased demand for water, sanitation and agriculture.

- **Agricultural demand:** Agriculture is one of the largest consumers of freshwater (for irrigation). Inefficient irrigation methods and crops with high water requirements (rice, cotton) exacerbate water scarcity.
- **Industrialisation:** Industries require large amounts of water for production and cleaning and discharge harmful pollutants into surface and groundwater, reducing water resources.
- **Pollution:** Industrial and household waste as well as chemicals used in agriculture contaminate freshwater resources and lead to their diminishing availability.
- **Inadequate water management:** The result of leaky infrastructure, outdated irrigation and poor waste management.
- **Transboundary water conflicts:** One country can prohibit another country's access to freshwater and prevent the sharing of water.
- **Lack of infrastructure:** In developing regions, limited access to water storage, treatment and supply systems increases the burden.

Award a maximum of three causes.
Award **3 marks** for two identified and explained causes.
Award **1 mark** for an identified and explained cause.
Award **0.5 mark** for identified cause without an explanation.

Accept any other relevant and correct answer.

3 m

3. Describe three **socio-economic impacts** of water scarcity.

Point marking.

Suggested answers:
- **Decline in agriculture:** Lower yields due to droughts and lack of irrigation systems can lead to food shortages and higher food prices.
- **Food insecurity** increases as agriculture suffers from reduced availability of irrigation water, leading to higher food prices and potential conflicts over resources.
- **Migration and displacement:** People may be forced to move due to decreasing water supplies. Migration to cities increases pressure on urban infrastructure.
- **Water conflicts:** Competition for scarce water can lead to local and cross-border tensions and disputes between different countries and social groups.
- **Health problems:** Poor water quality is a breeding ground for the spread of diseases (cholera, dysentery), as are inadequate sanitary facilities and low hygiene standards.
- **Gender inequality:** Women and girls in less developed countries are often responsible for fetching water, which can take many hours and limit their time for education and paid work.
- **Industrial decline:** Cuts in industrial production that requires large amounts of water (e.g. textile, chemical and food industries), leading to increased operating costs.
- **Reduced energy production:** In hydropower plants due to lower water volumes, but also in thermal and nuclear power plants, which require large amounts of water for cooling.

Award a maximum of three impacts.
Award **3 marks** for two outlined impacts.
Award **1 mark** for an outlined impact.
Award **0.5 mark** for a listed impact without short explanation.

Accept any other relevant and correct answer.

3 m

4. **Study Resource Booklet Figure C2.**
Explain why the countries of the **northern Mediterranean** are likely to experience major water stress in the future.

Point marking.
Level marking.

Suggested answers:

- **Climate change:** The summer drought in the Mediterranean climate leads to a shortage of water at the time when it is most needed (agriculture, tourism, etc.). Prolonged droughts and even lower rainfall will increase the pressure on existing freshwater sources.
- **Growth of tourism:** These countries are among the most visited by international tourism in the world, with the number of users increasing in summer, when water availability is at its lowest. Tourism trends show a trend towards further growth and over tourism in certain areas.
- **Agricultural demand:** This is one of the most intensive and productive agricultural areas in Europe with a high proportion of irrigated crops (especially fruit and vegetables). Growing production and potentially lower rainfall will increase pressure on scarce freshwater, especially in summer when water demand is at its highest.

A complete answer must refer to all three elements.
Award a maximum of **3 marks** for a complete answer that consists of all three elements. All answers have to include climate change and tourism. Agriculture can be replaced by another equally important reason.
Each element explained must relate to the current situation and the reason for the increased pressure on water resources in the future.
Award **1 mark** for each well explained element.
Award **0.5 mark** for each partially explained element.

Accept any other relevant and correct answer.

3 m

5. Outline three **strategies** for reducing water stress. The strategies must be related to actual, real-world situations.

Point marking.

Suggested answers:

- **Desalination:** The process of removing salt from seawater so that it can be used as drinking water or for agricultural and industrial purposes. It is mainly used in countries with limited water resources (Kuwait, UAE, Saudi Arabia). As the process is expensive, it can be used in coastal and island regions where there are no other options for obtaining fresh water.
- **Reservoirs for freshwater storage:** Large man-made reservoirs built on rivers or even on land reclaimed from the sea (e.g. Plover Cove in Hong Kong) are used to store freshwater for water supply.
- **Reuse and recycling of water:** After treatment, wastewater can be used for irrigation, as technical water and for other purposes instead of using fresh water that has to be preserved for drinking (e.g. Singapore).
- **Storage and utilisation of rainwater:** In many Mediterranean regions, rainwater is collected and stored in reservoirs in houses and public buildings. Many companies (e.g. Ikea) now collect rainwater from the roof and use it as technical water, e.g. for flushing toilets, instead of using fresh water.

- **Agricultural management:** Reduced water demand in agriculture can be achieved through the use of sprinkler irrigation, which reduces volume and runoff, and precision agriculture, which relies on sensors and data to optimise irrigation. In more extreme cases, crops that require irrigation (e.g. strawberries, tomatoes) can be replaced by crops that are adapted to drought and require less or no irrigation (e.g. olives, figs, etc.).
- **Public and domestic water efficiency:** Repairing leaky infrastructures, using water-saving devices (toilets, washing machines, dishwashers, showers, etc.), changing habits (e.g. showering in 5 minutes) and using recycled water (e.g. for toilets, car washes, etc.).
- **Restoration of ecosystems:** Restore degraded ecosystems (e.g. regulated rivers, wetlands) that support water retention and filtration and contribute to the natural water cycle.

Award a maximum of three strategies.
Award **1 mark** for each well elaborated strategy with an example.
Award **0.5 mark** for each partially elaborated strategy or a strategy without an example.
Do not award listing strategies without elaboration.

Accept any other relevant and correct answer.

Section D: Global energy consumption

Resource Booklet Figure D1 shows the structure of world energy consumption by source from 1965 to 2018.
Resource Booklet Figure D2 represents world coal consumption in selected countries and regions from 1978 to 2020.
Resource Booklet Figure D3 shows the electricity consumption in selected countries and regions in 1990, 2000, 2015 and 2025.
Resource Booklet Figure D4 gives the projected global primary energy consumption by region until 2050, made in 2010.

2 m

1. Explain the difference between **renewable** and **sustainable** energy sources. Use specific examples of energy sources in your explanation.

   Point marking.

   Answer:
   - **Renewable energy** is usable energy derived from a naturally occurring source or process that can be replenished faster than consumed. renewables produce little to no greenhouse gas emissions. They tend to be abundant and replenish naturally. Examples: solar, wind, hydropower, geothermal, ethanol, tidal, biofuel…
   - **Sustainable energy** is a renewable energy source that can be consistently used without jeopardizing its availability for future generations. Not all renewables represent sustainable energy (e.g. hydropower, biofuel). Hydropower, for example, requires dams that alter the natural environment and often displace people, so it cannot be considered sustainable. Plants that produce biofuel require significant natural resources and their consumption generates greenhouse gases.

   Award a maximum of **2 mark** for both explanations with concrete examples.
   Award **1 mark** for an explanation of renewable energy and at least two concrete examples.
   Award **1 mark** for an explanation of sustainable energy and explanation of one non-sustainable renewable source (biofuel, hydropower…).
   Award **0.5 mark** for each incomplete explanation or a complete explanation without concrete examples.

3 m

2. **For this question, refer to Resource Booklet: Figures D1.**

   Describe the main trends in the global consumption of **oil**, **coal** and **renewable energy** from 1965 to 2018.

   Point marking.

   Suggested answers:
   - **Oil** seems to continue being a commonly used form of energy. The energy crises in 1972 and 1979 are seen as dips in the graph. In the same way the financial crisis in 2007 is seen.
   - Concerning **coal**, it is necessary to understand that the growing population and industrialization in countries like China and India play a major role in the growth in the period between 2000 and 2014. The latest trend shows a stabilized consumption of coal.
   - It is obvious that the use of **renewable resources** is growing. This could be due to the agreements on reducing the use of fossil fuels in order to reduce the carbon dioxide emission (Paris Agreement)

Award a **maximum of 3 marks** for an answer that contains all three sources of energy.
Award **1 mark** for a complete description of each source of energy.
Award **0.5 mark** for a partial description of each source of energy.

Accept any other relevant and correct answer.

3 m

3. Explain three **environmental impacts** of using coal as a source of energy.

Point marking.

Suggested answers:

- **Air pollution:** Burning coal releases a large amount of pollutants into the atmosphere, including sulphur dioxide (SO_2) (causes acid rain), nitrogen oxides (NO_x) (contributes to smog and respiratory problems, PM 2.5 and PM 10 particles (tiny particles that can penetrate deep into lungs and cause heart and lung diseases), mercury and heavy metals (toxic to humans and wildlife, especially affecting brain development in children).
- **Greenhouse gas emissions:** Coal is one of the most carbon-intensive fuels. Burning it releases large amounts of carbon dioxide (CO_2), a major greenhouse gas. This contributes significantly to global warming and climate change.
- **Acid rains:** Coal combustion emits sulphur dioxide and nitrogen oxides, which form acids when combined with moisture in the atmosphere. Acid rains damage forests and soil, kill aquatic life in lakes and rivers, erodes buildings and monuments…
- **Water pollution:** Coal mining and coal-fired power plants can pollute water through acid mine drainage (rainwater reacts with exposed rock from mining, creating acidic water that leaches heavy metals into streams), ash ponds (storage of coal ash from combustion can leak toxic substances into groundwater).
- **Land degradation:** Surface mining, such as strip mining and mountaintop removal, removes vast areas of vegetation and soil, destroying habitats and altering landscapes. This leads to loss of biodiversity, increased soil erosion, long-term ecosystem damage…
- **Health impacts:** Pollution from coal use causes or worsens respiratory diseases, cardiovascular problems, and premature death.

Award a maximum of three impacts.
Award **3 marks** for two explained impacts.
Award **1 mark** for a completely explained reason.
Award **0.5 mark** for a listed reason without an explanation.

Accept any other relevant and correct answer.

3 m

4. **For this question, refer to Resource Booklet: Figures D2 and D3.**

Suggest three reasons why energy consumption in **developed countries** has not increased significantly, or in some cases has even decreased, since the 1990s.

Point marking.

Suggested answers:

- Industries in developed countries use more advanced technologies that require less energy.
- In the wealthier countries, households can afford to invest in solar panels, energy saving facilities etc.

- The heavy energy and raw material consuming industries have ben outsourced to less developed countries.
- Shift to tertiary economy and decrease in population growth.

Award a maximum of three reasons.
Award **3 marks** for three suggested reasons.
Award **1 mark** for any of suggested answers.

Accept any other relevant and correct answer.

4 m

5. **For this question, refer to Resource Booklet: Figure D4.**

Due to the current geopolitical situation, Western companies are relocating manufacturing industries from Asia back to their home country or neighbouring region. Discuss four possible **changes** to global primary energy consumption as a result of these relocations.

Suggested answer:

- **Redistribution of energy consumption:** Relocating factories from China to Western countries would likely reduce energy consumption growth in Asia, especially in China, and increase energy demand in OECD countries. The overall global impact would depend on how efficiently energy is used in the new locations and whether greener technologies are adopted in the process.
- **Decrease in Asia's energy consumption:** As shown in the graph, Asia (mostly China) is projected to lead global energy demand. If manufacturing declines due to relocation, China's industrial energy use would decrease, especially for coal, electricity, and industrial fuels. Decrease in energy consumption due to economic stagnation/recession.
- **Increase in OECD countries' energy consumption:** Relocating factories back to OECD regions (like the US and EU) would lead to an increase in energy demand in those areas, particularly for electricity and natural gas used in manufacturing.
- **Industrial energy usage rebalancing:** China’s energy consumption is currently high due to energy-intensive industries (e.g., steel, cement, electronics). Moving these industries to Western countries would re-shift the burden of industrial energy use back to developed economies, potentially reversing the downward trend seen in the dark blue (OECD) section of the graph.
- **Global emissions redistribution:** Emissions would shift geographically, not disappear. Western countries typically use cleaner and more efficient technologies, so carbon emissions per unit of energy might decrease, but overall global energy consumption could still rise due to less-efficient restructuring.
- **Energy efficiency and cost impacts:** Western factories may adopt more energy-efficient practices, which could reduce the total energy required for the same output. However, higher labour and energy costs in OECD countries might reduce total production unless automation offsets them.
- **Impact on future projections:** If large-scale reshoring (returning production to home countries) occurs, future energy projections (like those shown for 2040 and 2050) could change: Non-OECD demand may rise more slowly than projected. OECD demand may flatten less or even increase modestly.

Award a maximum of four arguments.
Award **4 marks** for three explained changes.
Award **1 mark** each well discussed change.
Award **0.5 mark** for each partially discussed change.
Do not award any marks to listed changes without explanations.

Accept any other relevant and correct answer.

Section E: The Darién Gap

Resource Booklet Figure E1 shows main routes of irregular migration in the world.
Resource Booklet Text Box E1 provides basic information on the Darién Gap.
Resource Booklet Figure E2 shows the location of the Darién Gap.
Resource Booklet Figure E3 provides data on the annual migration through Darién Gap from 2010 to 2024 by country of origin.

1 m

1. For this question, refer to Resource Booklet: Figure E1.
Identify the **primary direction** of irregular migration routes worldwide.

Point marking.

Answer:
- From global South to global North. / From underdeveloped to developed. / Least developed countries to more developed countries.

Award **1 mark** for the current answer.
Do not award **0.5 mark**.

Accept any other relevant and correct answer.

2. For this question, refer to Resource Booklet: Text Box E1; Figures E2 and E3.

4 m

a) Analyse the general **trend and sources** of migration through the Darién Gap. Justify your answer with specific data.

Point marking.

Suggested answers:
- Migration through the Darién Gap has increased since 2010, but the most intense growth has taken place since 2021, when more than 130,000 people crossed the Darién Gap.
- The highest peak was recorded in 2023 with more than 500,000 crossings. In 2024, the number was slightly lower, but still very high at 300,000 migrants.
- Until 2015, migrants from Cuba had the majority, from 2016 to 2020 migrants from Haiti dominated with 100,000 crossings or about 80% of all crossings in 2020.
- The strong increase since 2021 corresponds with a strong migration from Venezuela (150,000 – 300,000 people annually) and with more than two thirds of all migrants.
- Since 2021, an increasing number of crossings have been recorded from other South American countries (especially Colombia and Ecuador) and increasingly also from overseas countries (especially China).

A complete answer must contain at least **four elements**:
- Description of the trend until 2020 and total number of crossings.
- Description of the trend since 2021 and total number of crossings (answer must mention the highest peak in 2023).
- Description of dominant regions until 2020 (the Caribbean) and since 2020 (South America; overseas countries).
- Specific countries that dominated in each period and identification of exact years (Cuba until 2015, Haiti 2016-2020, Venezuela since 2021, increasingly Ecuador, Colombia and China).

Award a maximum of **4 marks** for a complete answer.
Award **1 mark** for each complete element (that includes both underlined segments).
Award **0.5 mark** for each partial element (that includes one underlined segment).

Accept any other relevant and correct answer.

3 m

b) Explain **two socio-economic** and **one environmental reason** for emigration from countries shown on the diagram. Use specific country examples to justify your answers.

Point marking.

Suggested answers – **socio-economic reasons**:

- **Economic crisis or collapse** – e.g. the fall in oil prices plunged Venezuela into economic crisis (fuelled by political instability). Hyperinflation rendered salaries worthless and unemployment rose, leaving many families without an income.
- **Food and medicine shortages** – e.g. economic sanctions in Cuba exacerbated the serious situation in Cuba, as did the economic downturn in Venezuela, leading to shortages of essentials such as food and medicine.
- **Political instability** – e.g. government disfunction and assassination of government officials in Haiti (president in 2021) has led to chaos and fighting over territory by various military groups and gangs
- **Authoritarian power and/or dictatorship** – an authoritarian government and lack of personal and political freedom led to personal discontent and oppression (e.g. in Cuba and Venezuela)
- **Insecurity, crime and gang violence** – e.g. high crime rates, violence, lack of political power have made life dangerous and living conditions unsustainable (e.g. in Venezuela and Haiti).
- **Extreme poverty** – many people live below the poverty line because there are no jobs, high unemployment, precarious working conditions, lack of basic services (e.g. health, education…), leading to a vicious circle of poverty (e.g. Haiti, Venezuela, Ecuador, Colombia).

Suggested answers – **environmental reasons**:

- **Earthquakes** – e.g. the powerful earthquake in Haiti in 2010 killed more than 200,000 people, left many homeless and led to economic collapse and political chaos.
- **Hurricanes** – coastal and island countries, especially Haiti, were hit by hurricanes in 2016 and subsequent years, destroying crops, homes and infrastructure that had already been severely affected by the 2010 earthquake.
- **COVID-19** – severely affected poor countries with economic and political problems and/or environmental disasters. Many people lost their jobs and livelihoods, and many households were left without income.
- **Diseases** – e.g. after a major earthquake and hurricane, accompanied by the absence of the government, poor sanitation in Haiti leads to occasional outbreaks of cholera.
- **Climate change** – prolonged droughts, hurricanes and floods have devastated agriculture, forcing farmers to leave their land and move to the cities or abroad (e.g. Colombia, Haiti…).

Award a maximum of **2 marks** for two socio-economic reasons and **1 mark** for one environmental reason.
Award **1 mark** for each explained reason that is associated by a particular country.
Award **0.5 mark** for a general explanation without a specific country-related example.
Do not award reasons that are listed without an explanation.

Accept any other relevant and correct answer.

2 m c) Suggest **two reasons** why migrants from countries outside South America choose the Darién Gap route to their destination instead of other alternatives.

Point marking.

Suggested answers:

- Many migrants originally from the Caribbean (e.g. Haiti, Cuba), Asia (e.g. China, India) and Africa were already living and working in South America before they decided to move north. COVID-19 and the associated political and economic problems (e.g. loss of jobs) forced them to move to the USA in search of better living opportunities.
- Due to strict border controls on air travel, border controls between the USA and Mexico and strict naval controls near the Caribbean coast of the USA, small and unregistered vessels risk rapid deportation, making migration by land the only option.
- It is easier to get a visa for South American countries and then continue to the north as illegal migrants.

A complete answer must contain **both answers** (previous stay in South America and border controls).
Award a maximum of **2 marks** for a complete answer.
Award **1 mark** for each suggested and explained reason.
Award **0.5 mark** for a suggested reason without an explanation.

Accept any other relevant and correct answer.

3 m 3. For this question, refer to Resource Booklet: Text Box E1.
Outline **three threats** that make crossing the Darién Gap extremely difficult for migrants.

Point marking.

Suggested answers:

- **Heavy rainfall** – the tropical rainforest in the Darién Gap is one of the wettest areas in the world, and heavy rainfall can lead to landslides and flash floods.
- **High temperatures and high humidity** – unfavourable weather conditions lead to excessive sweating and dehydration, which exacerbates exhaustion after days of hiking through the deadly terrain.
- **Dangerous terrain** – steep and muddy mountains with no roads make traversing the terrain extremely difficult. The combination of steep slopes and dense vegetation makes crossing extremely difficult.
- **Dangerous rivers** – wide rivers with strong currents that have to be crossed on foot put lives at risk.
- **Wildlife** – the presence of potentially dangerous wildlife, especially poisonous snakes, jaguars, mosquitoes that transmit diseases (e.g. malaria, dengue fever…).
- **Crime and violence** – the corridor is controlled by armed military groups, drug traffickers and gangs. Migrants are often robbed, injured or killed if they resist, while women and girls are sexually abused.
- **Lack of assistance** – there is no government control, medical or other assistance. In case of injuries, assaults or other problems, there is no one to help the migrants.
- **Navigation** – easy to get lost.

Award a maximum of **3 marks** for a complete answer.
Award **1 mark** for each listed and outlined threat.
Award **0.5 mark** for a listed threat without an explanation.

Accept any other relevant and correct answer.

2 m 4. For this question, refer to Resource Booklet: Text Box E1.
When Bajo Chiquito became the main reception centre for migrants, how might this have impacted **services and built environments** in the village? Give at least four specific examples.

Point marking.

Suggested answers:

- New catering facilities related to large mass of people crossing through the village – rooms for rent, restaurants and food courts.
- New (small) grocery stores for a large mass of people.
- Auxiliary services and facilities for people in transit – currency exchange offices, mobile charging stations, wi-fi spots.
- Appearance of non-governmental and humanitarian organizations (Red Cross).
- Founding health facilities and mobile medical teams that heal migrants.
- Increase in built environment and transformation of a former small village into an urban centre with services.
- Congestion of town streets with people and tents for a short stay during the transit.

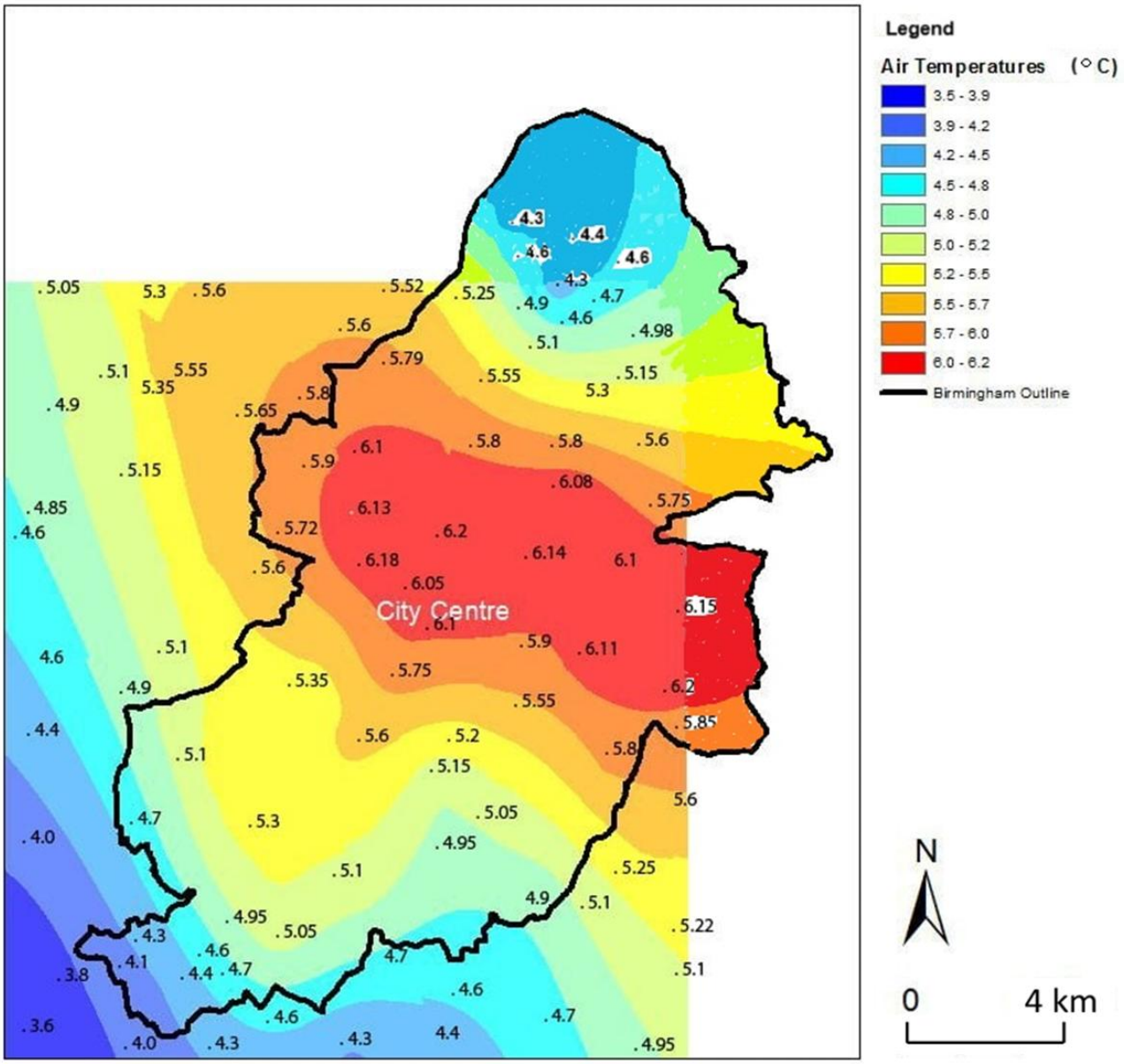
Award a maximum of **2 marks** for a complete answer that consists of four listed elements.
Award **0.5 mark** for each listed answer.

Section F: Urban Heat Island

Resource Booklet Figure F1 shows satellite image of Birmingham and the surrounding urban area.

3.5 m

1. Draw an **isopleth (air temperature) map** for Birmingham and the surrounding urban area.
   Draw isopleths at **3.9, 4.2, 4.5, 4.8, 5.0, 5.2, 5.5, 5.7** and **6.0 °C**.
   Colour the map and fill in the legend.
   Note: air temperature data was for the night of February 19th 2014. The average temperature was 5.2 °C.



Point marking:
1m – correctly drawn contours/isolines at 3.9, 4.2, 4.5, 4.8, 5.0, 5.2, 5.5, 5.7 and 6.0°C
2m – proper selection of colour ramp (palette): **2 different colours** ("warm" for temperatures over the average 5.2°C, "cool" for temperatures under the average 5.2°C); colours have to be correctly **graduated:** as shown in the map legend
(award only 1m if the student selected only *one colour* palette and correctly graduated it – higher temperatures in dark tone/shade, and lower in light tone/shade)
0.5m – correctly filled legend

For this question, refer to Study Resource Booklet: Figure F1.

1.5 m

2. Analyse the satellite image and the map you drew in Q1.
Identify the area of Birmingham where urban heat island has formed and **describe** the land use in the area identified.

Point marking:
Area: city centre / central part of the city (**0.5m**)
Land use: densely built area (**0.5m**), with little green area (**0.5m**)

4 m

3. Explain four **environmental** impacts of urban heat islands worldwide.

Point marking:
Award **1m** for each **named and explained** environmental impact.
Award **0.5m** for **only named** environmental impact but not well explained.

Impact 1:
Air Quality and Greenhouse Gases
- Urban heat islands increase demand for energy consumption during the summer when temperatures rise.
- Most electricity is produced from combusting fossil fuels. Thus, pollutants from most power plants include sulphur dioxide (SO2), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), and mercury (Hg) - these pollutants contribute to air quality problems which are exacerbated by higher temperatures.
- Air pollutants from vehicles and industries tend to get trapped in the cities and increase respiratory risks.
- Fossil-fuel-powered plants emit greenhouse gases, particularly carbon dioxide (CO2), which contribute to global climate change.

Impact 2:
Water Quality/Waterways pollution
- Urban heat islands degrade water quality through thermal pollution.
- Hot pavement and rooftop surfaces transfer their excess heat to stormwater, which then drains into storm sewers and raises water temperatures as it is released into streams, rivers, ponds, and lakes.

Impact 3:
Energy Use
- Higher summertime temperatures cause an increased demand in energy consumption through air conditioning.
- The increased demand for energy puts excess pressure on the power grid and can sometimes result in blackouts or brownouts during hot summer months.

Impact 4:
Animals/Animal ecosystems
- Temperature changes associated with urban heat islands can cause changes in the availability of food and water, which affects eating and foraging habits of animals.
- Temperate climates experience an extended growing season – that can alter breeding strategies of inhabiting species and cause problems for the species, as a result of the warming caused by urban heat islands.
- Thermal pollution of water bodies affect all aspects of aquatic life, especially the metabolism and reproduction of many aquatic species.

- Rapid temperature changes in aquatic ecosystems as a result from warm stormwater runoff can cause stress to aquatic life – it may be even fatal.

6m

4. Name three **strategies** that cities can implement to mitigate the urban heat island effect and evaluate the **effectiveness** of the strategies you selected.

Level Marking:

Level 3 (5-6m):	Demonstrates a thorough understanding of the urban heat island effect and its relation to climate change Clearly explains and evaluates 3 distinct strategies to mitigate the urban heat island effect Provides a balanced assessment of the effectiveness of named strategies, considering their advantages and limitations Uses specific examples or case studies to support the evaluation Demonstrates excellent use of geographical terminology
Level 2 (3-4m):	Shows a good understanding of the urban heat island effect Describes 3 strategies to mitigate the urban heat island effect Attempts to evaluate the effectiveness of the strategies, but the assessment may be unbalanced or lack depth May provide some examples, but they are not fully developed Uses some geographical terminology
Level 1 (1-2m):	Demonstrates basic knowledge of the urban heat island effect Identifies one or two strategies to mitigate the urban heat island effect Limited or no evaluation of the strategies' effectiveness Lacks specific examples or supporting evidence Limited use of geographical terminology

Possible strategies include:
- Green infrastructure (e.g., urban forests, green roofs, vertical gardens)
- Cool pavements and reflective surfaces
- Urban design and planning (e.g., building orientation, street layout)
- Water features and fountains
- Heat-resistant building materials
- Urban ventilation corridors

Evaluation can cover the following:
- Cost-effectiveness
- Implementation challenges
- Long-term sustainability
- Adaptability to different urban contexts
- Co-benefits (e.g., air quality improvement, biodiversity enhancement)
- Public acceptance and participation

Model Answer:
Strategies that cities can implement to mitigate the urban heat island effect are the implementation of green infrastructure and the use of cool pavements and reflective surfaces.
Green infrastructure, such as urban forests, green roofs, and vertical gardens, can be highly effective in reducing urban temperatures. These features increase vegetation cover, which provides shade and enhances

evapotranspiration, thereby cooling the surrounding air. For example, Singapore's Gardens by the Bay project has demonstrated how large-scale green infrastructure can create cooler microclimates within a dense urban environment. The effectiveness of this strategy lies in its multiple co-benefits, including improved air quality, enhanced biodiversity, and increased urban aesthetics. However, the implementation of green infrastructure can be costly and requires long-term maintenance, which may be challenging for cities with limited resources.

The second strategy, the use of cool pavements and reflective surfaces, involves modifying urban surfaces to increase their albedo (reflectivity). This approach can significantly reduce heat absorption and storage in urban materials. Cities like Los Angeles have implemented cool pavement programmes, reporting temperature reductions of up to 6°C in treated areas. The effectiveness of this strategy is evident in its relatively quick implementation and immediate effects. Additionally, it can be applied to existing infrastructure without major redesigns. However, the long-term durability of these materials and their performance under different weather conditions may limit their effectiveness over time.

When evaluating these strategies, it's important to consider their adaptability to different urban contexts. Green infrastructure may be more suitable for cities with available space and adequate water resources, while cool pavements might be more appropriate for densely built areas with limited green space. Both strategies can be highly effective when implemented as part of a comprehensive urban heat mitigation plan.

In conclusion, while both green infrastructure and cool pavements are effective strategies for mitigating the urban heat island effect, their success depends on factors such as local climate conditions, urban morphology, and available resources. A combination of these approaches, tailored to the specific needs and characteristics of each city, is likely to yield the most effective results in addressing urban heat challenges in the face of climate change.

end ■