13th International Geography Olympiad

Beijing, China

16–22 August 2016

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 per marker and double-checker.
   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, 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, one of the designated Moderators – Anu or Dubravka.

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 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 and additional answers or answers not accepted and hand them in after marking to improve the final Marking Scheme.

14. The Moderators (Anu and Dubravka) will sample the marking of all teams.

Written Response Test
Contributions from: Belgium, China–Hong Kong, Czech Republic, Indonesia, Poland, Singapore
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Deputy: Dubravka Spevec (Croatia)
Editors: Jason Flowers (USA), Celestine Hang (Singapore), Alexey Naumov (Russia)
Director of Tests: Susan Lomas (UK)

Section A: Landslides

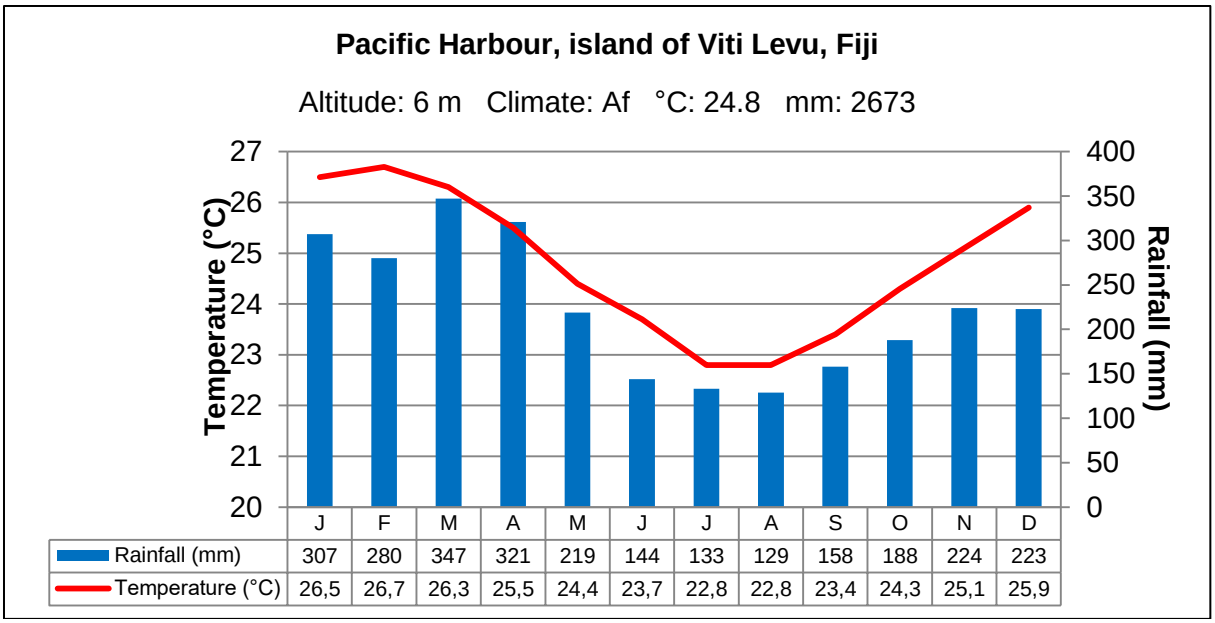
1m

1. Study Resource Booklet Figure A1: A photograph taken on the island of Viti Levu, Fiji.
Which of the locations A–F was **most recently** affected by a landslide?

Answer: point marking
B (1m).

1m

2. Study the figure below: The climatic data of Pacific Harbour, a city on the island of Viti Levu, Fiji.
Which 4 months have the highest risk of landslides?



	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall (mm)	307	280	347	321	219	144	133	129	158	188	224	223
Temperature (°C)	26,5	26,7	26,3	25,5	24,4	23,7	22,8	22,8	23,4	24,3	25,1	25,9

The climatic data of Pacific Harbour, a city on the island of Viti Levu, Fiji (http://en.climate-data.org/location/775064).

Answer: point marking
January to April (1m).

3m

3. Identify 6 **natural** triggers that can cause landslides.

Answer: point marking
Any reasonable list of **different triggers** (not initial conditions like geology, topography (relief) – steepness of slopes or gravity etc.), each correct answer 0.5m.
Landslide is “Movement of a mass of rock, debris or earth down a slope” (slides, falls, flows, topple and (lateral) spread).

- Weathering.
- Heavy precipitation (rainfall, storms and tropical cyclones etc.).
- Hydrogeology (aquifers saturation, seepage, change in groundwater level, liquefaction etc.).
- Snowmelt (seasonal).
- Retreat of glaciers.
- Flooding.
- Fluvial erosion (undercutting of cliffs and banks by rivers etc.).
- Coastal erosion (wave action, tidal currents, wave currents; high winds – aeolian erosion).
- Slopes dried out and cleared by fire (excluding human induced fires).
- Earthquakes and its vibrations.
- Tectonic movements.
- Volcanic activity and eruptions.
- Tsunami.
- Previous landslides.
- Fall of a meteorite.
- The effect of global warming (perhaps not totally natural factor) was considered only in case of its direct influence explained (i.e. the retreat of glaciers, the melting of permafrost, increase of sea water, heavier and longer rainfalls etc.).

3m

4. Identify 6 **human** activities that can cause landslides.

Answer: point marking
Any reasonable list of **different** triggers, each correct answer 0.5m.

- Removal of vegetation.
- Interference with or changes to natural drainage.
- Damming of water.
- Irrigation.
- Modification (cutting and filling) of slopes by development by construction of buildings, urbanisation etc.
- Modification (cutting and filling) of slopes by development by construction of roads, railways, tunnels etc.
- Vibrations from heavy traffic.
- Leaking pipes (water, sewer).
- Mining activities, blasting and excavation or displacement of rocks.
- In residential development, natural river beds are often filled with soil to make a flat ground. Such filing will make an unstable slope susceptible to earthquake-induced landslides even when the slope is very gentle.
- Inadequate agricultural practices (crop planting and animals grazing counted separately).
- Recreational activities (pressure on surface caused by uncontrolled trekking etc.).
- Climate changes caused by human activities (CO_2 emission).
- Nuclear weapons testing blasts.
- War (bombing).

3m

5. Give 3 ways in which a landslide can cause damage to the environment and to people.

Answer: point marking
Any reasonable list of **different** damages no matter the category.

- **Fatalities**.
  - Killing people and animals.
- **Damage**.
  - Engulfing people, animals, crops and buildings causing injuries and damage to property.
  - Cutting off all infrastructures: roads, power lines, pipes, and communication lines, leaving people stranded.
  - Ruining economic viability including food gardens and cash cropping areas.
- **Secondary effect**.
  - **Alteration of the landscape**. Landslides (debris avalanche) can create huge gaps in the vista and dam rivers, flooding surrounding areas and creating lakes.
  - **Landslide dam outburst floods**. Failure of a landslide dam, which has trapped large volumes of water behind it, can cause catastrophic flooding downstream.
  - **Tsunamis**. Large landslides underwater or into the sea may create tsunamis.
  - **Reef damage**. Landslides cause severe soil erosion and deposit this sediment in rivers, which then carry it into the sea causing considerable damage to the surrounding coral reefs.

4m

6. Outline 2 measures that can **reduce** the possibility of landslides occurring.

Answer: level marking

- No other remedy will yield better results than **avoiding** landslide-prone areas altogether by consulting engineering geologist or a geotechnical engineer to evaluate the potential for landslides and other geology-related problems.

Landslide may be prevented by stabilisation of slope. There are three basic approaches:

- **Geometric methods**, in which the geometry of the hillside slope is changed. Rock slope and soil slope geometric modifications will require different techniques.
- **Hydrogeological methods**, in which an attempt is made to lower the groundwater level or to reduce the water content of the material.
- **Mechanical methods**, in which attempts are made to increase the shear strength of the unstable mass or to introduce active external forces (e.g. anchors, rock or ground nailing) or passive external forces (e.g. structural wells, piles or reinforced ground) to oppose the destabilising forces.

Once constructed, remedial measures must be inspected and maintained. Lack of maintenance can cause renewed landslide movement.

- **Preserving vegetation (reforestation)**:
  - Trees, grasses, and vegetation can minimise the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil.
  - Although vegetation alone cannot prevent or stop a landslide, removal of vegetation from a landslide-prone slope may initiate a landslide.
- **Improving surface and subsurface drainage**:
  - Surface water should be diverted away from the landslide-prone region by channelling water in a lined drainage ditch or sewer pipe to the base of the slope but not to be allowed to pond.
  - Ground water can be drained from the soil using trenches filled with gravel and perforated pipes or pumped water wells.
  - Swimming pools, water lines, and sewers should be maintained to prevent leakage, and the watering of lawns and vegetation should be kept to a minimum.
  - Clayey soils and shales have low hydraulic conductivity and can be difficult to drain.
- **Constructing piles and retaining walls (terraces, benches)**:
  - (Friction) piles (metal beams, as wooden beams and telephone poles are not recommended for use as piles because they lack strength and can rot) are fixed to extend into a competent rock layer below the landslide.
  - Retaining walls can be constructed by adding lagging (metal, concrete, or wooden beams) horizontally between the piles.
  - Such walls can be further strengthened by adding tiebacks and buttressing beams.
  - Retaining walls also are constructed of concrete, cinder blocks, rock, railroad ties, or logs, but these may not be strong enough to resist landslide movement and could topple.
  - Sheet piling.
- **Rock fall protection**:
  - Loose blocks of rock are attached to bedrock with rock bolts, long metal rods that are anchored in competent bedrock and are threaded on the outside for large nuts.
  - Geo Grid, shotcrete.
- **Removal and replacement (altering the slope gradient)**:
  - Landslide-prone soil and rock can be removed and replaced with stronger materials, such as silty or sandy soils.
  - Must include measures to prevent continued weathering of the remaining rock.
- **Legal approach**:
  - Land use regulation, abstaining from building houses / practicing agriculture etc. in landslide-prone places.

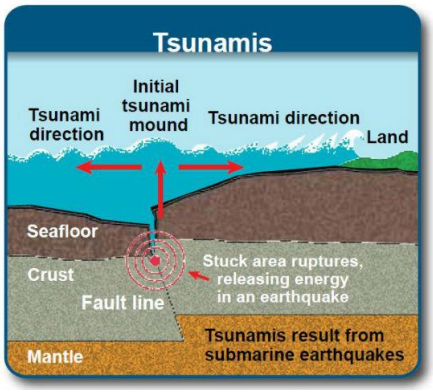
Section B: Tsunamis

4m

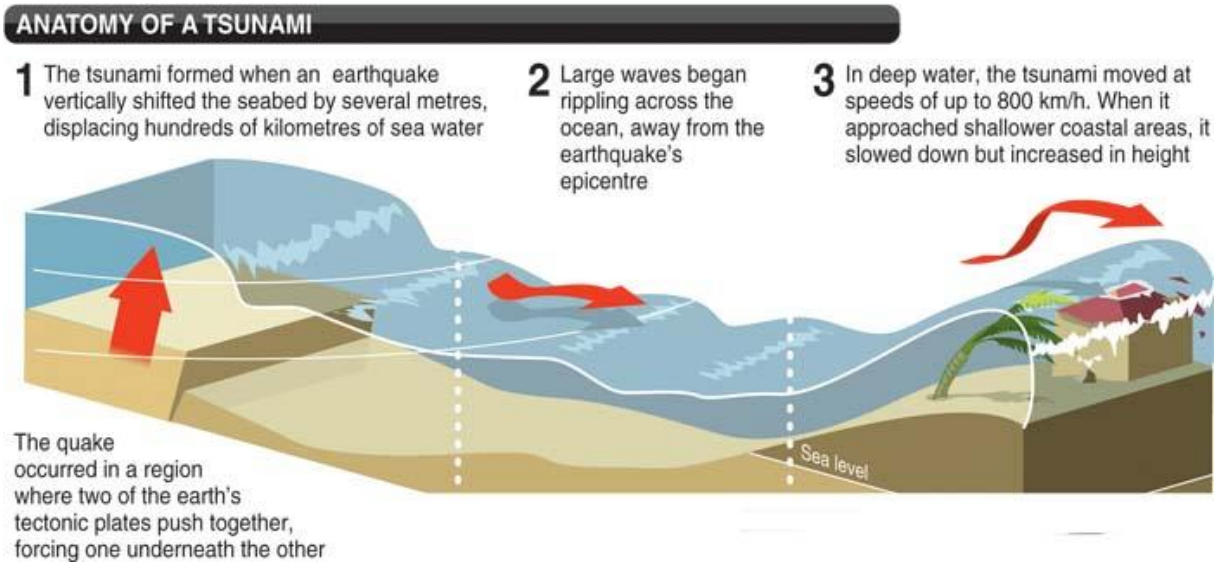
1. Draw an **annotated** diagram(s) to show how a **tsunami** can be caused by an **earthquake**.

Answer: point marking
- Submarine earthquake (1m).
- Displaced column of water (1m).
- Increasing wave height (and lower speed) towards shore (1m).
- Annotation (different from labelling) (1m).

Possible diagrams:



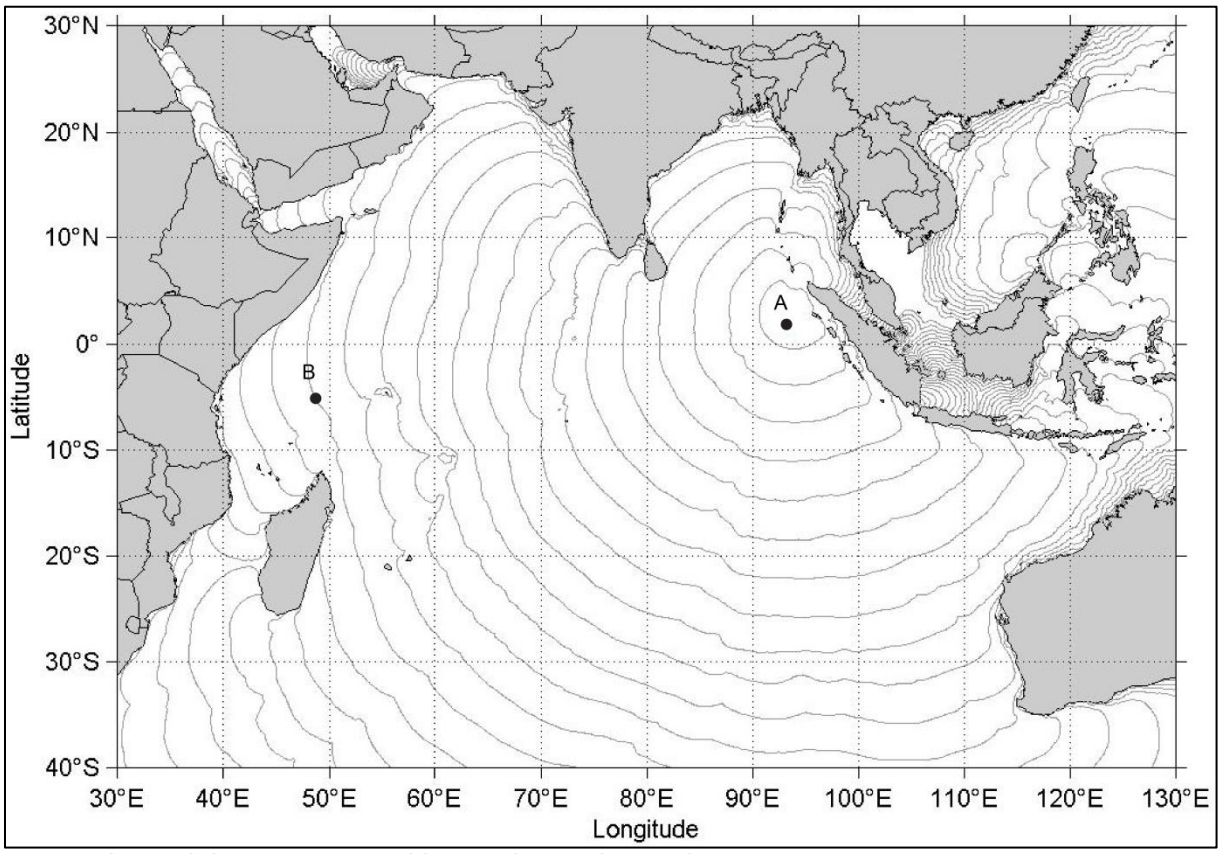
(https://ec.gc.ca/meteo-weather/default.asp?lang=En&n=279AC7ED-1&offset=3&toc=show).



(http://www.abc.net.au/news/2014-12-19/anatomy-of-a-tsunami/5979690).

2m

2. Study the figure below: Tsunami travel time contours with 30 minutes interval.
   a) Provide the coordinates of the point A.
   b) If the tsunami occurred at 06:57 GMT at the location marked by the point A, what time would it reach point B on the map?

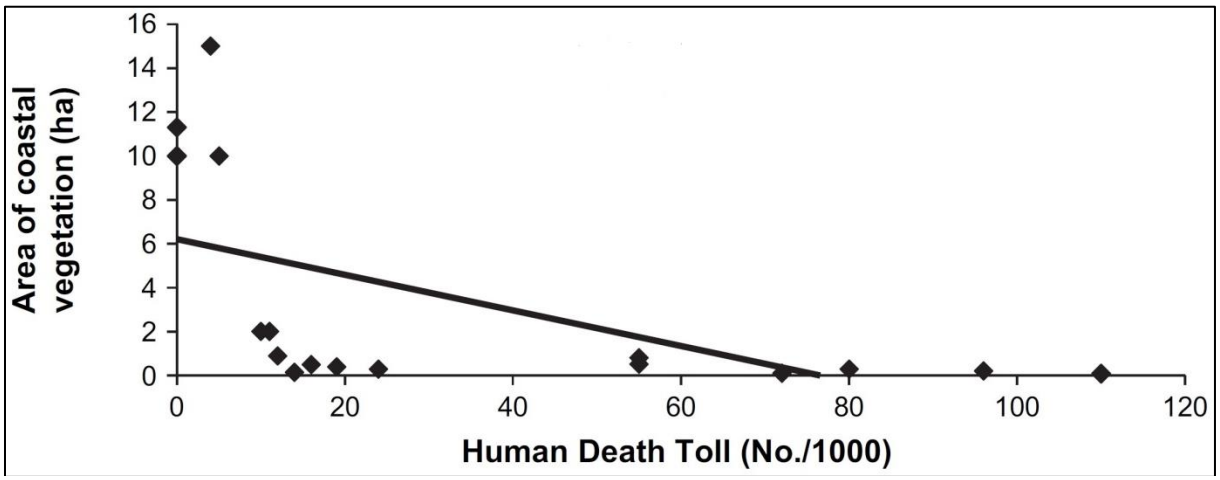


Tsunami travel time contours with 30 minutes interval
(http://www.incois.gov.in/DSSProducts/Product_RTWP/Web/images/02_dss120110183700_travel_time_A.jpg).

Answer: point marking
a) 2–3°N, 93–94°E (1m).
b) 13:57 GMT (1m).

2m

3. Study the figure below: The relationship between the area of coastal vegetation and human death toll in various districts in Tamil Nadu, India in the wake of the Boxing Day Tsunami of 2004.
Describe the **relationship** between the area of coastal vegetation and human death toll.



The relationship between the area of coastal vegetation and human death toll in various districts in Tamil Nadu, India in the wake of the Boxing Day Tsunami of 2004
(Kathiresan, K. and N. Rajendran 2005: Coastal mangrove forests mitigated tsunami. *Estuarine, Coastal and Shelf Science* 65 (3): 601–606, figure 2, p. 604, doi: 10.1016/j.ecss.2005.06.022).

Answer: point marking

- **Main point**: inverse relationship: greater the area of coastal vegetation, the lesser the human death toll from the correlation line on the graph (1m).
- Any **additional reasonable comment** with referring to specific numbers where necessary (1m).
    - The correlation line does not describe well the overall situation where there are three clusters of districts from left to right:
        - large areas (ca 10–15 ha) with coastal vegetation corresponds with ca 0–5 deaths/thousand,
        - areas of ca 0–2 ha corresponds with ca 10–25 deaths/thousand,
        - areas of ca 0–2 ha can corresponds with also up to ca 55–110 deaths/thousand.
    - Anomaly: the death toll on very small areas (ca 0–2 ha) of coastal vegetation has a very wide span ranging from ca 10–110 deaths/thousand, whereas the death toll on larger areas (> 10 ha) varies much less, ranging from ca 0–5 deaths/thousand against reason.
    - For clearer and more comprehensive results the districts with ca 2–10 ha of coastal vegetation could have been included but perhaps there were not any.
    - The graph does not say anything about the background and comparability of districts used, i.e. were they of the same areal size, was the population density the same in all areas (concentrated vs. dispersed settlements), were the district from the same distance from the sea, are these from the same height etc.

4m

4. Explain 2 ways in which the establishment or maintenance of **coastal vegetation** can aid in tsunami hazard management.

Answer: level marking

- Reflect and resist tsunami energy, reduce inundation depth, inundation area and tsunami current.
- Stop driftwood and other materials moved by tsunamis, and to prevent the secondary damage by driftwood impact.
- Prevent people from being washed out to sea.
- Reduce erosion of beaches and dunes which also act as barriers against tsunamis.
- Mangroves' wave attenuation is because of the mangrove forests function as sinks for the suspended sediments.

3m

5. In 2004 the Boxing Day Tsunami waves brought illegally dumped **radioactive nuclear waste** onto Somalia's coast.
Explain its effect for Somalia's **economy**.

Answer: level marking

Significant pollution of coastal waters ruined local marine life (ecosystem) causing fishing industry which played an important role in Somalia's economy to collapse resulting in loss of jobs and income.

- Due to collapsing of fishing industry many Somali men became pirates.
- Health risk for workforce.
- Spending money on cleaning radioactive nuclear waste is reducing the budget for economic development.
- Fewer tourists bring less income.
- Reduce the foreign investment.

Section C: Phewa Lake in Nepal

1m 1. Study Resource Booklet Figure C1: Height contour map of the region around Phewa Lake. Estimate the height of the surface of the lake.

Answer: point marking
Any number or range between 761–800 m above sea level as the elevation lines have 40 m height difference the exact height of the water surface cannot be detected. Around or ±800 m above sea level also marked as correct answer, as the lake crosses the 800 m isoline at some points (1m). Answers above 820 m above sea level marked 0m.

1m 2. Study Resource Booklet Figure C1: Height contour map of the region around Phewa Lake. Estimate the length of the perimeter of Phewa Lake.

Answer: point marking
Breaks at: 17 km and 21 km (both including), so: $17 \leq x \geq 21$ km (1m).

4m 3. See next page.

2m 4. Study Resource Booklet Figure C3: Change in Phewa Lake area between 1988 and 2012. Describe the **changes** in the area of Phewa Lake between 1988 and 2012.

Answer: point marking
- Lake reduced in size (0.5m), approximately 300,000–450,000 m^2 or 5–10% (0.5m).
- Separation into two lakes; not constant shrinking, as the period 1988–1999/2003 shows larger shrinking rate; reduced on the western side of the lake (1m), “on the left” (0m).

4m 5. Study Resource Booklet Figure C2: A land use map of the Phewa Lake Catchment Area. Explain how the **land use** surrounding Phewa Lake can **affect** the lake in 2 ways.

Answer: level marking
- Land use (0.5m),
- affect (0.5m),
- link (reason, explanation, process) between land use and affect (1m).

Examples:
- Surrounding degraded forests may eventually lead to more runoff and sedimentation in the lake, thus increasing the height and size of the lake.
- Surrounding cultivated hill slopes may lead to runoff of fertilizer and eutrophication in the lake, killing off the biodiversity in the lake.
- The dense protected forest on the southeastern shore can have a positive effect on the water quality of the lake.

4m

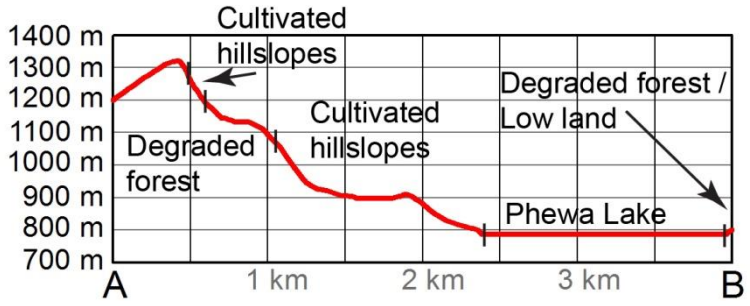
3. Study Resource Booklet Figures C1: Height contour map of the region around Phewa Lake and
C2: A land use map of the Phewa Lake Catchment Area.
Draw a **labelled** profile of the transect A–B using **both** maps.

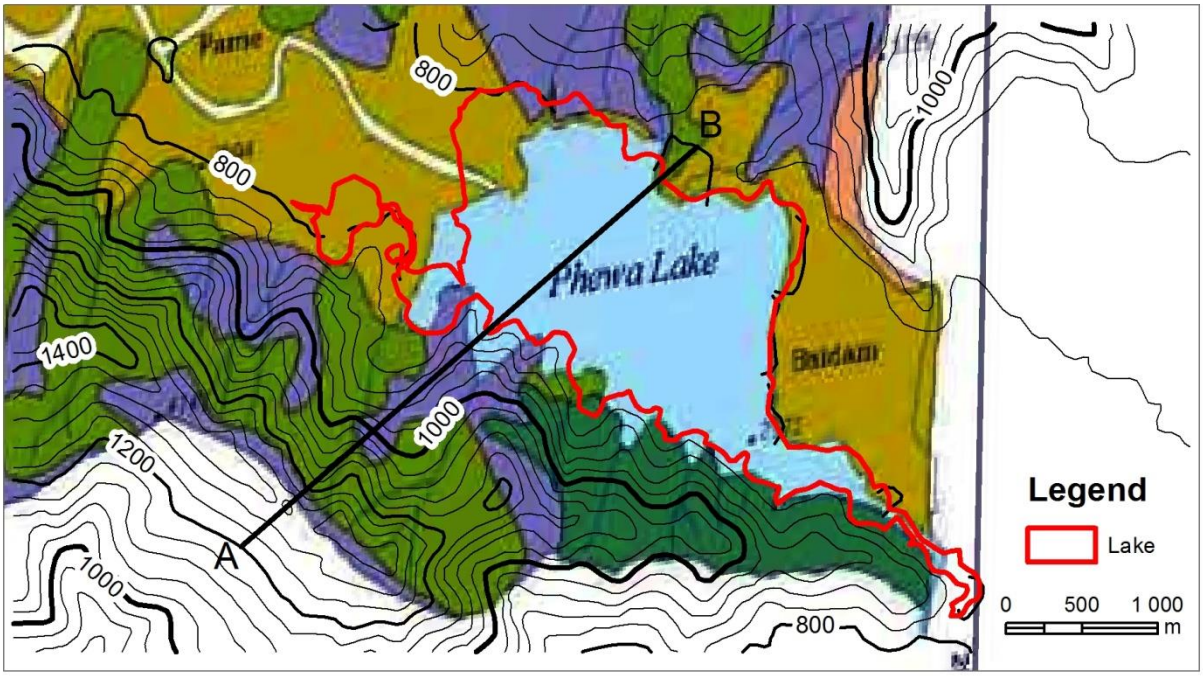
Answer: point marking

- Elevation (shape) of the profile line (2m), maximum of 1 minor mistake in profile (1m).
- Labelling the land use and lake (1m).
- Proper labelling of units of Y-axis (1m).

Notes:

- The correct height of the surface of the lake is 761–800 m above sea level as the elevation lines have 40 m height difference the exact height of the water surface cannot be detected (see question C1).
- The two maps are from different years, projections and scale – but this is real life geography of not matching maps and students cannot use georeferencing and even then the shape of the lake is not perfect (see below). Allow flexibility.
- If the profile is too way off (e.g. no hill/lake recognisable at all), no points are given for land use and Y-axis.
- The vertical lines and kilometres are only for informative reasons for markers.





3m

6. Evaluate the impact of recreational development on Phewa Lake area.

Answer: level marking

- Impact can be evaluated based on the potential problems and opportunities (positive and negative impact) of this development for the area and its inhabitants – a holistic appraisal of the impact.
- Additionally, responses could include a range of impact – economic benefits to the residents, environmental impact on the lake or the clearance of forest for hotels or roads with more people etc.
- It could also include a consideration of time period (duration/timing) i.e. in the long term and the short term, the scale of impact, and relevance to the lake and its environment, including recognition that is it in a developing country.

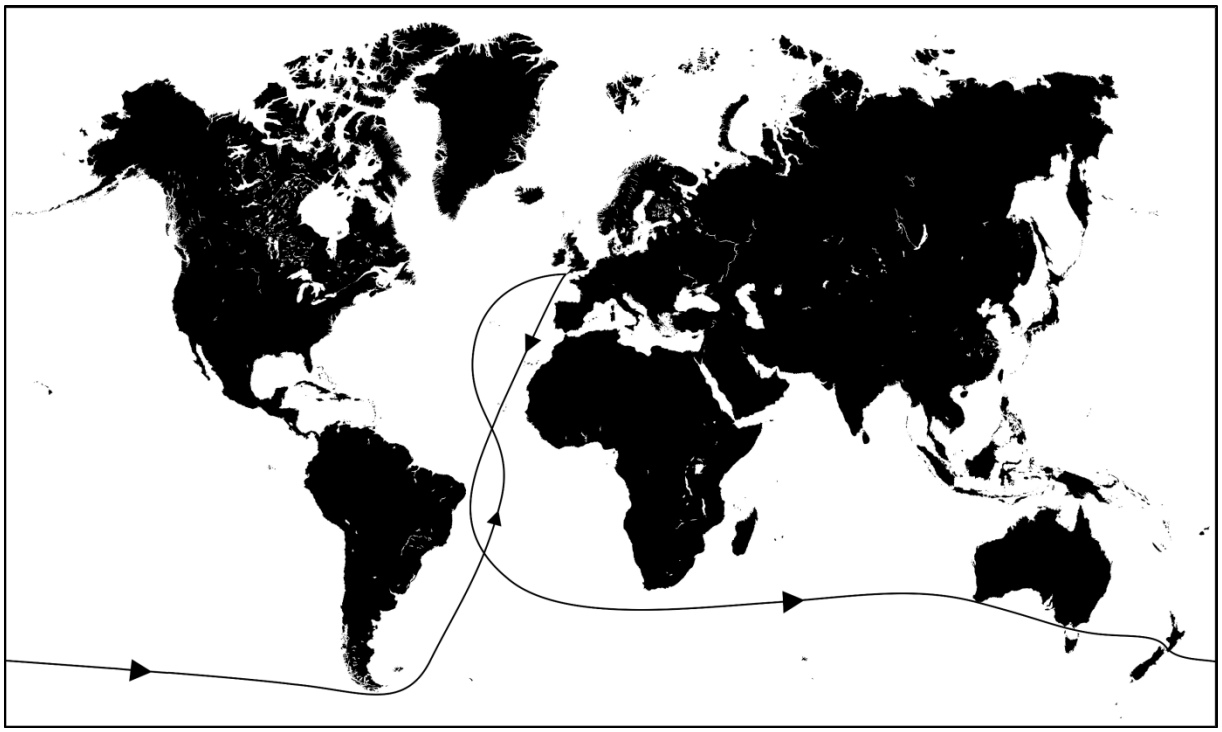
Examples:

- **1m**: at least two well explained reasons of which one has to be social/economic. List of impacts is maximum of 1m.
- **2m**: + classified/labelled (environmental, economic, social, ecological etc.) impact from different aspects. Keywords: On the other hand… / However… / But… / Positive and negative effects.
- **3m**: + comparison or weighted conclusion, or in depth geographical analysis with also secondary impact / different scales / different time scale (long term – short term), or consideration of broader context.

Section D: Wind Speed

1.5m

1. Study the figure below: The sailing ships route.
   Describe where and explain why sailing ships experienced the highest (wind) speeds?



The sailing ships route
(original: https://upload.wikimedia.org/wikipedia/commons/f/f7/ClipperRoute.png,
cartographic base: http://www.vectorworldmap.com/vectormaps/vector-world-map-v2.2-blank.jpg).

Answer: point marking

- Area: 40–60°S, southern part of Indian, Atlantic and Pacific Oceans, Southern Ocean; accept markings on the map (0.5m).
  - Reason: Occurrence of strong, western winds, Westerlies, Roaring Forties, Furious Fifties (1m); no large landmasses to slow down / disrupt wind speed (1m).

3m

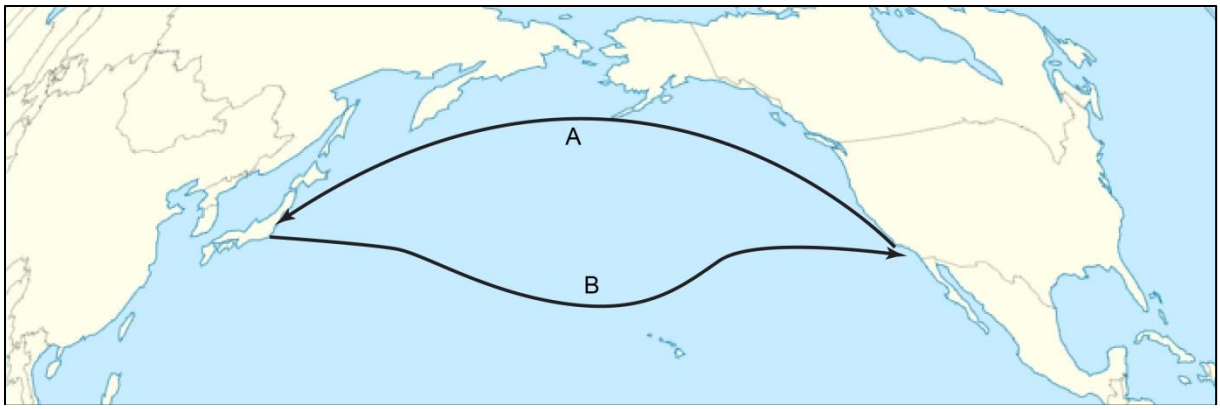
2. From the figure: The sailing ships route (map above),
   describe where and explain why they experienced decreased (wind) speeds?

Answer: point marking

- Area 1: Horse latitudes (~30°N and ~30°S); accept markings on the map (0.5m).
  - Reason: Occurrence of calm or weak winds in the area of tropical highs, between the zone of the trade winds and the Westerlies (1m).
- Area 2: Around the equator, doldrums; accept markings on the map (0.5m).
  - Reason: Occurrence of calm or weak winds associated with Intertropical Convergence Zone (1m).

2m

3. Study the figure below: The approximate plane flight routes.
   a) Explain why route A is usually used when flying from America to Asia.
   b) Explain why route B is usually used when flying from Asia to America.



The approximate plane flight routes
(original: https://en.wikipedia.org/wiki/…#/media/File:…_…_routes.svg,
cartographic base:
https://en.wikipedia.org/wiki/Template:Location_map_Pacific_Ocean#/media/File:Pacific_Ocean_laea_location_map.svg).

Answer: point marking
a) Route A is the shortest (corresponding to orthodrome (great circle)) (1m).
b) Route B corresponds to the location of jet stream (from west to east) taking thus less time and fuel despite being longer (1m).

2.5m

4. Study Resource Booklet Figure D1: Wind speed and wind turbine power output.
   a) What is the minimum wind speed necessary for a wind turbine to produce electricity?
   b) Specify in which wind conditions a wind turbine can produce the greatest power output.
   c) Why is no electricity produced at very high wind speeds?

Answer: point marking
a) 2–3 or ~2.5 m/s (0.5m).
b) Wind speed 12–25 m/s (0.5m), steady, not variable wind (0.5 + 0.5 = 1m).
c) The blades of the turbine will be automatically blocked to prevent storm damage (1m).

1m

5. Study Resource Booklet Figure D2: Distribution of annual mean wind speed at 80 m above ground level.
Explain why the mean wind speed in the area indicated on the map by arrow A is significantly higher than in the surrounding regions.

Answer: point marking
The flat surface of the water (Caspian Sea) allows the wind to blow with higher speed than in surrounding regions with greater roughness of the terrain (moderately hilly and mountainous) (1m).

3m

6. Study Resource Booklet Figures D2: Distribution of annual mean wind speed at 80 m above ground level and
D3: A photo of a wind farm.
The area indicated on the map by arrow B has one of the highest mean wind speed in Africa. Give 3 reasons why the area is **not** used for the location of **wind farms**.

Answer: point marking
Any reasonable list of **different** reasons no matter the category.

- **Natural reasons**: due to Sahara the demand for electricity is not high as the small local nomad population are not electricity consumers (human/economic reason),
  - sandstorms damage (1m).
- **Resource reasons**: oil and phosphates in the area, which makes profit (Western Saharan electricity production by source: fossil fuel: 100%, hydro: 0%, nuclear: 0%, other (including solar and wind): 0%; exports: 0 kWh, imports: 0 kWh),
  - no need, expertise, know-how and skills to develop local large electricity-intensive industries also due to political situation and missing local population,
  - weaker economy as a Less Economically Developed Country (LEDC) associated reasons (1m).
- **Political situation** is unstable in the region, e.g. in Western Sahara,
  - Entrepreneurs unlikely to develop electrical networks and associated infrastructure to transmit electricity over long distances to industrial consumers (1m).

2m

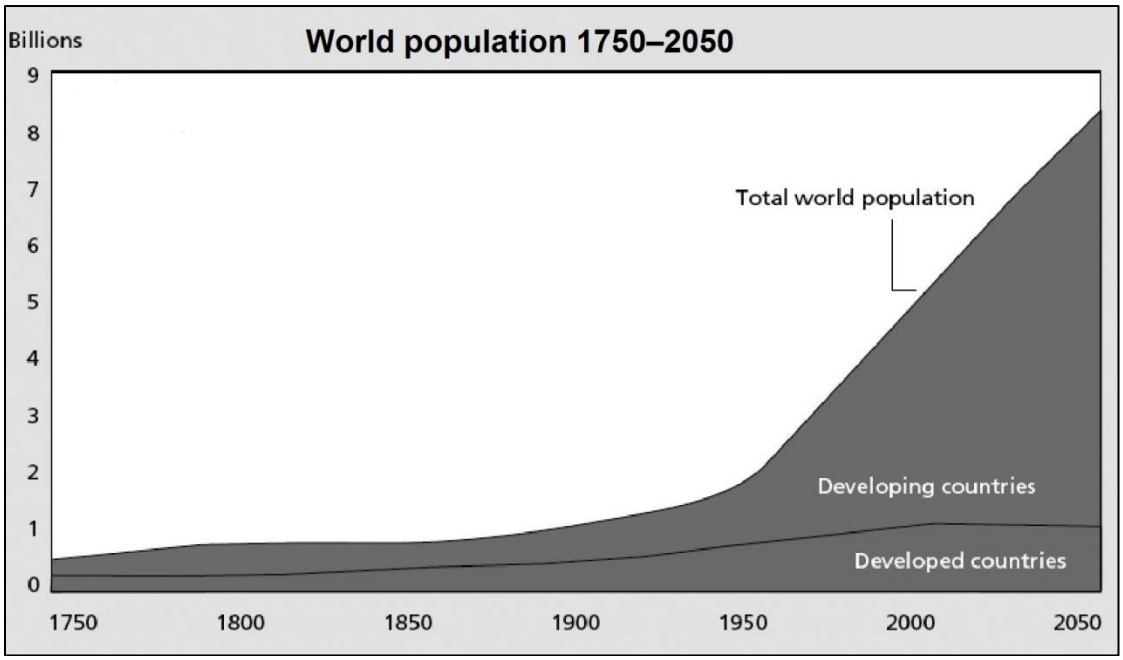
7. Study Resource Booklet Figure D2: Distribution of annual mean wind speed at 80 m above ground level.
Explain why Greenland, which is not known for hurricanes, hosts some of the strongest winds on the planet, called **tip jets**.

Answer: point marking
Tip jets occur when cyclones (also effect of gulfstream on wind speed) **meet with the land mass (obstacle)** causing **air flow to be distorted and winds to speed up** to a gale-force wind. The air parcels that are forced to go around Greenland have a longer path than those that go over it and because they have to all meet up at the end, the ones that go around have to accelerate (known as the Bernoulli effect, which also results in lift on an airplane wing) (2m).
Accept explanation on pressure differences due to high pressure over ice cap and low pressure at coast/ocean and resulting air movement and wind speed (1m).

Section E: Population Trends and Challenges

2m

1. Study the figure below: World population 1750–2050.
   Give 2 reasons why total world population growth accelerated significantly after 1950.



World population 1750–2050
(Population Reference Bureau, 2011).

Answer: point marking

- Development of new medical insights / improved public health care influenced on mortality decline.
- Improved living conditions / standard (understanding of the importance of hygiene…).
- Increased food production in developed countries enabled more effective help to developing countries.

4m

2. Suggest 4 measures which a fast growing population / country should include in its *Family Planning Policy* in order to **control its population growth** in the future.

Answer: point marking

- Encourage more education and awareness about birth control especially in rural areas.
- Award scholarships for education, especially of girls.
- Improve economic and health / medical conditions and raise the standard of living.
- Raise the marriageable age for men and women.
- Suggest 1-child or 2-child family policy.
- Creating more public (door-to-door) campaigns to widespread awareness of family planning (through TV, radio, newspapers etc.).

2m

3. One of the most dominant contemporary demographic processes in developed countries is that of an **ageing population**.
   Outline 2 **positive** implications of this process.

   Answer: point marking
   - Old retired person can do part-time work (they often have greater skills and experience than younger workers).
   - Old retired persons can contribute to their community through voluntary work (services).
   - Grandparents often provide free (unpaid) childcare.

5m

4. See next page.

2m

5. Study Resource Booklet Tables E1: Age and sex structure in United Arab Emirates (UAE) (2014),
   E2: United Arab Emirates (UAE) selected demographic data (2000–2014) and
   your **population pyramid**.
   Suggest a reason for the unbalanced age and sex structure of the United Arab Emirates (UAE) population, and **explain** the underlying cause(s) behind that.

   Answer: level marking
   Unbalanced age and sex ratio in UAE occurred due to international migration (very high net immigration) – many younger economically active foreigners came to work here in the oil fields and on construction sites. The majority of them were men and they mostly arrived unaccompanied by their families.

5m

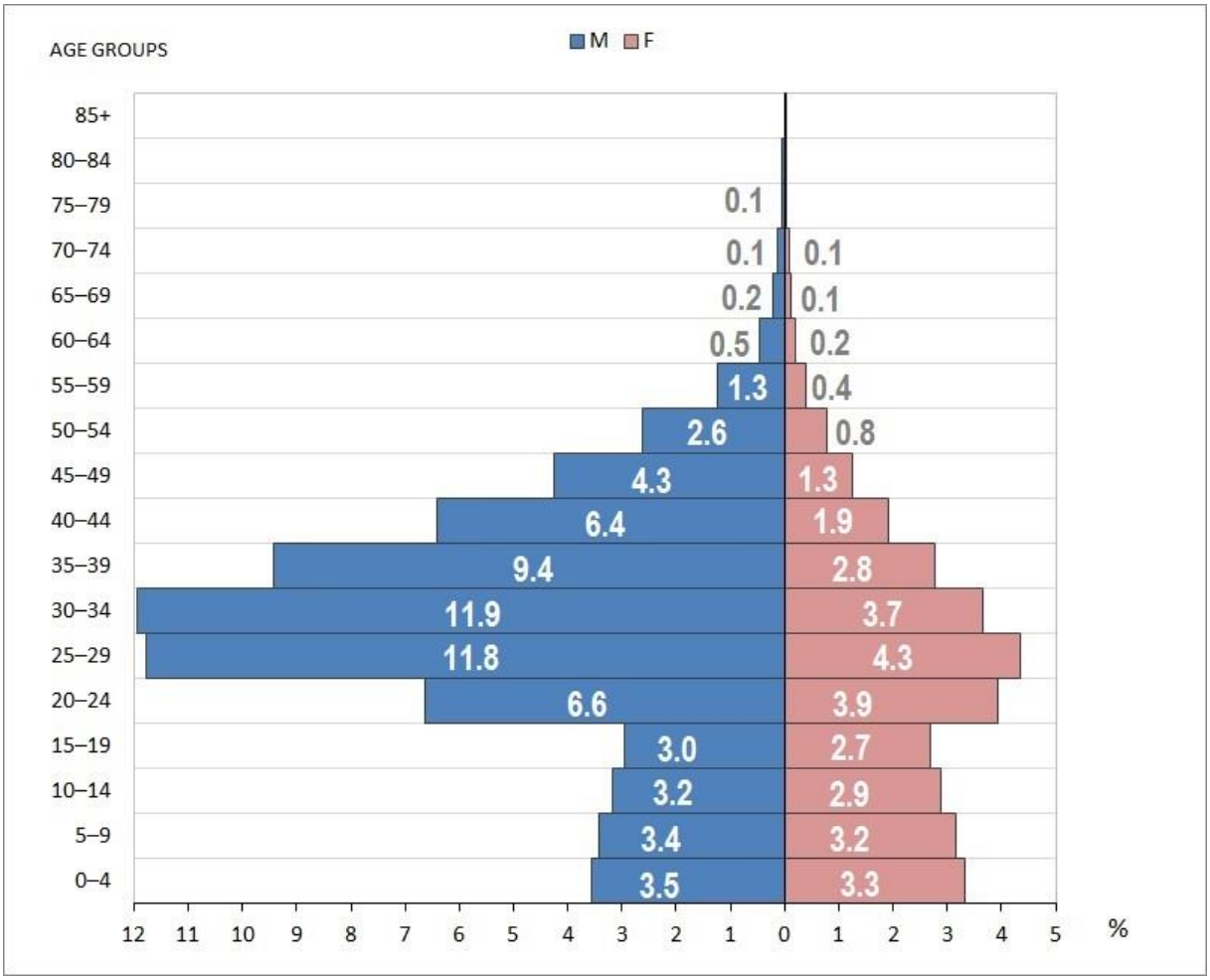
4. Study Resource Booklet Table E1: Age and sex structure in United Arab Emirates (UAE) (2014).
Draw United Arab Emirates' (UAE) **population pyramid** showing the **share (%)** of the population.

Answer: point marking

- Labelling Y-axis ("Age group(s)") or writing it in between the male and female columns (0.5m)
- Labelling X-axis ("% of population" or "%") (0.5m).
- Inserting a legend or writing "M(ale)" and "F(emale)" within a graph (0.5m).
- Correct positioning of male (left) and female (right) (0.5m).
- Correctly locating the "0 – zero" point in the X-axis (1m).
- Correctly drawing male (1m) and
- female (1m) columns.

Notes:

- The pyramid should be adopted to the given box, i.e. not too large or small.
- The share (%) of respective age-sex group is only for informative reasons for markers.

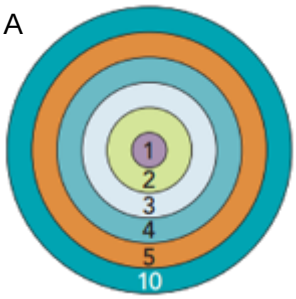
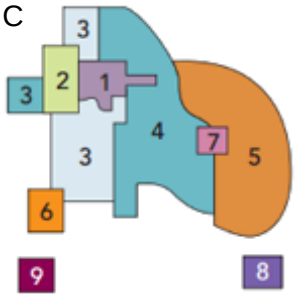


Section F: Urban Theories and Development

3m

1. Study the figures A–C below: Urban development models.
   The numbers and shades refer to different land uses.
   Describe the urban development in each of the 3 models.

Answer: point marking

Urban development model	Description of urban development
A 	**(Concentric zone model by Burgess (1925))** – students do not have to name the authors or models. The city has expanded outwards in rings with different land uses, whereas, CBD (Old Town, City) is located in the center (1) and is surrounded by industry and low-income housing. Medium- and high-income housing are located peripherally (1m).
B 	**(Sector model by Hoyt (1939))** – students do not have to name the authors or models. The city core is still in the middle but different land uses are allowed for an outward progression of growth radially towards city periphery and open countryside, e.g. along transportation or communication lines/corridors/routes; less desirable city zones closer to centre can witness decaying housing (1m).
C 	**(Multiple nuclei model by Harris and Ullman (1945))** – students do not have to name the authors or models. Illustrates multimodal nature of urban development in possibly urban sprawl environment where the core loses its importance and new industrial parks and residential suburbs have been formed outside of the city possibly forming a new core or edge city (1m).

(https://www.khanacademy.org/test-prep/mcat/social-sciences-practice/social-science-practice-tut/e/social-structures---passage-1).

2m

2. Study Resource Booklet Figure F1: A photo of Barcelona, Spain.
   a) Which area/zone (1–10) in the urban development models (see previous question) does this picture correspond to?
   b) What are 3 main characteristics of this area/zone?

Answer: point marking
a) "1" (0.5m).
b) Any reasonable list of **different** characteristics (3 x 0.5m = 1.5m).

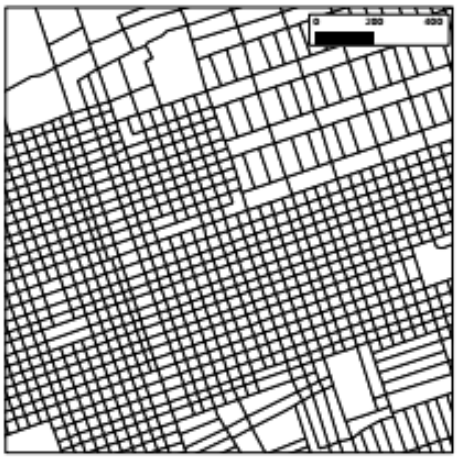
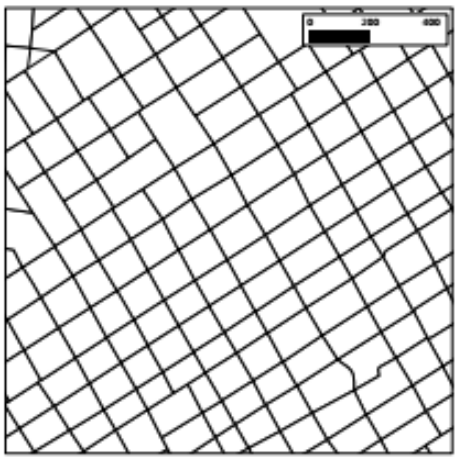
- Higher urban density; good infrastructure, accessibility; newest technologies, design.
- Higher prices of land and/or rent; people with higher income work there.
- Higher concentration of offices and retail buildings; business rather than housing.
- Location of many government offices.
- Often site of the tallest buildings in the city; modern, posh outlook.
- Cultural diversity (multinational corporations) and functions (theatres, cinemas, etc.).
- Big daytime, limited night time population.

2m

3. Study Resource Booklet Figure F2: Urban “fingerprints”.
Match the street block layouts (A, B, C and D) with the corresponding urban “fingerprints” graphs (1, 2, 3 and 4).

Answer: point marking
Each correct answer 0.5m (4 x 0.5m = 2m).

- Street block layout A corresponds to fingerprint graph no. 2 (0.5m).
- Street block layout B corresponds to fingerprint graph no. 4 (0.5m).
- Street block layout C corresponds to fingerprint graph no. 1 (0.5m).
- Street block layout D corresponds to fingerprint graph no. 3 (0.5m).

A  Street block layout A corresponds to fingerprint graph no.: 2 (0.5m).	B  Street block layout B corresponds to fingerprint graph no.: 4 (0.5m).
C  Street block layout C corresponds to fingerprint graph no.: 1 (0.5m).	D  Street block layout D corresponds to fingerprint graph no.: 3 (0.5m).

4m

4. Discuss how urban (spatial) structure influences **energy efficiency** in cities.

Answer: level marking
Urban form and transport systems are two major components of urban structure that influence energy efficiency in cities.

- Urban spatial structure determines energy demand and consumption (e.g. for transport and space heating/cooling in buildings) and opportunities for introducing alternative energy systems in urban areas (e.g. competitive public transport systems to reduce energy use).
- Dense, compact, diverse and concentrated cities contribute more to reduction of travel needs (mostly by car) and lower energy use for transport, and facilitate and favour the efficient use of energy ("green transport").
- Dispersed urban settlements characterised by physical separation of activities and with longer commuting distances affects one's travel needs and therefore energy requirements for transport (more frequent private car usage).

4m

5. The "smart city" concept of future urban development is being introduced in many countries. Elaborate how this concept can be **disadvantageous** for cities?

Answer: level marking

- Concept can contribute negatively to even more social differences between the city inhabitants (larger gap between poor and rich).
- Using information technology (hi-tech methods) cities can/will become more expensive.
- It can contribute even more to corruption, even though it might just become more sophisticated.
- Using modern technology in city management can lead to city services being shut down or personal information being released (technology being used to spy on citizens).
- Possible "domino effect" – the fact that cities are bound to become increasingly connected could also mean that a failure in one sector could lead to problems in others.