



17<sup>th</sup> International Geography Olympiad

Istanbul, Turkey

11 August – 16 August 2021

**Written Response Test**  
**Suggested Marking Guide**

## Note to WRT Markers

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The mark for each question is given in the margin at the end of the question.  
There is a maximum of 15 marks for each section.

Students were informed to write their iGeo student number and fill in the page numbers and Section numbers at the bottom of each page.  
Students were also informed that they should scan their documents in order of the page numbers.

Students not educated in English were allowed to use bilingual dictionaries during the test.

Time allocated:

150 minutes for students not educated in English.

120 minutes for students educated in English.

### **Written Response Test**

Contributions from: Croatia, Denmark, Finland and New Zealand  
Committee Convenor: Tan Li Ling (Singapore)  
Director of Tests: Shen Su-min (Taiwan/China-Taipei)

### Section A: Suez Canal Blockage

The container ship “Ever Given” was stuck in Suez Canal from 23<sup>rd</sup> to 29<sup>th</sup> March 2021. It was stated that the reasons for losing control of the ship were strong winds and a sandstorm. Resource A1 shows an image of the blockage taken from a satellite. Resource A2 shows the development of international maritime trade by cargo type in selected years. Resource A3 shows the leading 20 global container ports in 2018 and 2019.

- |  |                   |
|--|-------------------|
| <p>(a) (i) Name the country where the Suez Canal is located.<br/><i>Point marked.</i><br/>Answer: Egypt</p> <p>Award 0.5 mark for answer.</p>  | <p>[0.5 mark]</p> |
| <p>(ii) Name the two seas which the Suez Canal connects.<br/><i>Point marked.</i><br/>Answer: Mediterranean Sea and Red Sea.</p> <p>Award 0.5 mark if both seas are mentioned.</p>   | <p>[0.5 mark]</p> |
| <p>(b) Using the Koppen climate classification, identify the climate of the region where the Suez canal is in.<br/><i>Point marked.</i><br/>Answer: BWh or hot desert zone</p> <p>Award 1 mark if answer contains either BWh or hot desert zone.</p>   | <p>[1 mark]</p>   |
| <p>(c) Explain why sandstorms might occur at the Suez Canal.<br/><i>Point marked.</i><br/>Suggested answers:</p> <ul style="list-style-type: none"><li>• Desert (arid) climate – e.g. Location in constant high pressure areas, where cyclones cause strong pressure gradients and thunderstorms with increased wind speed over a large area.</li><li>• Subtropical maximum – e.g. Constant high pressure with subsidence of air that can create intensive pressure gradient in contact with cyclones, with few or no precipitation.</li><li>• Small amount of vegetation – e.g. Due to arid climate amount of vegetation is small so sand and dust are lifted from the bare ground to the atmosphere and transported to large distances.</li></ul> <p>Award 2 marks for each explained reason; 1 mark for unexplained reason. Accept any other relevant and correct answer.</p> | <p>[2 marks]</p>  |

- (d)** Explain two reasons why ships choose to ply the Suez Canal route, instead of taking alternative routes to travel between East Asia and Europe. [4 marks]  
*Point marked.*  
Suggested answers:
- Suez route is shorter and requires less fuel (i.e. travel expenses are lower)
  - Shorter route saves fuel and it is more effective use for the ship
  - Shorter route saves fuel and contributes to lower emissions of greenhouse gases
  - Suez Canal saves travel time 1-3 weeks compared to alternative
  - Lower risks of environmental hazards, particularly circumnavigation Cape of Good Hope (due to strong winds and high waves)
    - Less risks for environmental hazards, especially circumnavigating Cape of Good Hope is hazardous due to high winds
- Award 2 marks for each explained reason; 1 mark for unexplained reason. Accept any other relevant and correct answer.
- (e)** Study Resource A2. Briefly explain three reasons why containers are used so predominantly in global trade. [3 marks]  
*Point marked.*  
Suggested answers:
- Containers are easy to transfer, as they are standardized and can be used everywhere in the world
  - Containers are quickly loaded and unloaded
  - Containers can be transported easily using different means of transport (favourable for multi-modal transport) – e.g. container ships, trucks, trains, airplanes...
  - Containers can be stacked easily which saves space
- Award 1 mark for each reason. Accept only the 1<sup>st</sup> 3 written reasons by students. Do not mark from 4<sup>th</sup> reason onwards. No 0.5 marks given.
- Accept any other relevant and correct answer.
- (f)** Study Resource A3. Explain two risks which the container transport industry might face. [4 marks]  
*Point marked.*  
Suggested answers:
- Risks related to concentration of ports – a problem in one big port paralyzes the whole system of sea ports
  - Risks related to dependence of world's economy container transport – problems in container transport can represent a threat to global economy

- Risks related to dependence on only a couple of narrow straits and canals in container transport – e.g. Suez Canal, Panama Canal, Strait of Malacca, Strait of Hormuz, Bosphorus Strait
- Structural risks related to size of large vessel – risk of getting stuck
- Risk of possible container shortage in Asia – many goods are shipped outbound from Asia
- Vulnerability to geopolitical factors – conflicts, terrorism, piracy, blocking routes for political reasons
- Vulnerability to cyber-attacks – high dependence upon technology (navigation, management, control...)
- Vulnerability to natural hazards – storms, hurricanes, tsunamis, floods, strong winds, high waves...

Award 2 mark for each explained risk; award 1 mark for unexplained risk (up to a maximum of 2 unexplained risks). No 0.5 marks awarded.

Accept any other relevant and correct answer.

## Section B: Energy Sources and Regenerative Cities

Resource B1 shows world energy consumption from 1965 to 2015. Resource B2 shows primary production of energy from renewable sources from 1990 to 2015. Resource B3 shows Cambodia's energy mix in 2011. Resource B4 shows the Vertical Forest in Italy. Resource B5 shows the Bullitt Centre in Seattle with photovoltaic cells on its roof.

- (a)** Study Resource B1. Briefly explain two ways in which the trends observed in Resource B1 might differ between more economically developed countries and less economically developed countries. [2 marks]
- Point marked.*
- Suggested answers:
- Industrialization in the less developed countries that requires much energy (e.g. China)
  - De-industrialization and/or development of green industries in developed countries
  - Growing population in developing countries (e.g. China, Southeast Asia, Africa, Latin America)
  - Growing middle class in developing countries that uses more energy
  - Fear of running out of fossil fuels in developed countries
  - Growing awareness on pollution and climate change caused by human activities in developed countries
  - Investments into renewable energy sources in developed countries
  - Using low-energy devices and vehicles in developed countries due to strict regulations and efforts to achieve zero carbon emissions
- Award 1 mark for each reason. No 0.5 mark awarded.  
Accept any other relevant and correct answer.
- (b)** Study Resource B2. Describe the trends observed in the primary production of energy from renewable sources from 1990 to 2015. [2 marks]
- Point marked.*
- Suggested answers:
- Overall: total amount of energy from renewable sources has increased from approximately 70 million metric tonnes of oil equivalent to approximately 205 million metric tonnes of oil equivalent.
  - The primary production of energy from wood & other solid biofuels remains the largest from 1990 to 2015.
  - The significance of wind power is relatively more recent, with increasing production of energy from mid-1990s onwards.

- The significance of liquid biofuels is relatively more recent, with increasing production of energy from mid-1990s onwards.
- The significance of solar energy is relatively more recent, with increasing production of energy from mid-1990s onwards.
- Production of energy from geothermal energy has seen the smallest increase since 1990.
- Production of energy from hydropower is relatively unchanged since 1990.
- In 1990, there were about 5-6 sources of energy, as compared to 8 sources in 2015.

Award 0.5 mark for each description.

Accept any other relevant and correct answer.

- (c) Study Resource B2. Explain the socio-economic and environmental impacts of using renewable energy sources.

[4 marks]

*Point marked.*

Suggested answers:

**Positive environmental impacts:**

- Lower air pollution (compared to fossil fuels) (e.g. solar energy)
- Lower emission of greenhouse gases (e.g. in hydroelectric energy)
- No need for environmental degradation due to mining (e.g. coal)
- Use of resources available in unlimited amount (e.g. sun, wind, waves)
- Lower carbon emissions and potentially positive impact to climate change
- Use of water reservoirs in flood control, recreation, agricultural irrigation

**Negative environmental impacts:**

- Need for large areas for building water reservoirs required for hydroelectric plants
- Environmental and landscape degradation in mountain areas and valleys used as water reservoirs
- Disruptions in wildlife (e.g. wind turbines and bird migration)
- Change in natural water cycles when building dams – leading to erosion, loss of fertile mud
- Dams represent barriers for wildlife migration
- Use of hazardous materials in manufacturing (e.g. solar power)
- Need for large amount of water (e.g. in geothermal or biomass plants)
- Emission of hazardous and/or greenhouse gases (e.g. hydrogen sulphide, carbon dioxide, ammonia, methane, and boron in open-loop geothermal plants; biomass plants)
- Land subsidence in case of extracting geothermal water

- Increased earthquake risk in extracting geothermal water (due to high pressure close to main faults)

**Positive socio-economic impacts:**

- Increase in local employment related to new job opportunities in renewable energy projects and related industries (e.g. producing solar panels)
- A possibility to choose an energy source
- Use of local labour force, local materials, local shareholders and local services
- Producing energy at lower cost for consumers and increase of their purchase power
- Low impact on human health (small emissions of hazardous gases in most renewable sources)

**Negative socio-economic impacts:**

- Land use issues/conflicts with other activities (e.g. wind power or solar plants vs agriculture)
- Displacement of people to build reservoirs for hydro plants
- Use of large agricultural land for production of plants used for biofuel instead for food
- Loss of valuable agricultural land for food production
- High investments and maintenance costs (e.g. in solar plants)

Award 1 mark for each impact mentioned. Students must mention at least 1 socio-economic or environmental impact to score full 4 marks.

Accept any other relevant and correct answer.

**(d)** Study Resource B3. Explain two issues that may affect the sustainability of Cambodia's energy supply.

[4 marks]

*Point marked.*

Suggested answers:

- Increasing urbanisation and population growth that can result in more demand for electricity. There will be pressure to increase energy supply to meet this rising demand. Resources can be depleted.
- Reliance on imported energy from conflict zones can lead to issues of energy security.
- Lack of suitable sites for dam building and further development of hydropower.
- Upstream use of (transboundary) rivers might affect hydropower supply.
- Climate change (in the long-run) could affect water supply which can affect hydropower supply.



- Governance issues (e.g. corruption, mismanagement, delays affecting energy-related projects)
- Cost of exploration of fossil fuels as well as exploitation of fossil fuels may be unsustainable.
- Finite resources like coal and oil will deplete over time.
- Biomass includes burning plant matter for energy. This can potentially deplete forests/trees over time if used at an unsustainable rate.

Award 2 marks for each explained issue with data cited from B3; award 1 mark for unexplained issue without data. No 0.5 mark awarded.

Accept any other relevant and correct answer.

**(e)** Study Resources B4 and B5. Explain three ways in which these strategies can contribute to urban sustainability and liveability.

[3 marks]

*Point marked.*

Suggested answers:

- Less energy required for cooling – e.g. Green walls and roofs absorb short-wave Sun radiation and reduce radiation penetrating to rooms.
- Less energy required for cooling and heating – e.g. Due to use of building materials with better thermal isolation, less energy is required for cooling and heating.
- Better thermal comfort – e.g. Vegetation on balconies blocks direct Sun and overheating, while good isolation prevents from rapid cooling.
- Help to reduce heat islands in cities – e.g. Green buildings help cooling surrounding areas (similar to parks), as they emit less long-wave radiation (heat)
- More comfortable living in touch with nature (biophilic design) – e.g. People living in green buildings are in direct contact with nature, which affects positively their comfort
- Aesthetic values – E.g. More attractive urban areas with lots of greenery compared to streets with no trees and bare building facades
- Contribution to zero carbon emissions – E.g. Vegetation absorbs carbon dioxide produced in cities and helps to reduce its levels.
- Cities as nodes of production of energy – E.g. Buildings produce energy from solar panels and sell surplus to the electrical system or other buildings.
- Production of clean energy – E.g. Buildings with solar panels produce electric energy, energy for heating and cooking with no carbon emissions.
- More efficient use of energy – E.g. Buildings that produce energy are self-sustainable in terms of energy production and consumption.

Award 1 mark for each explained issue with clear reference to B4 and B5. No 0.5 mark awarded. Answers must link back to concepts of urban sustainability and

liveability. Answers must be explained clearly. No marks awarded if student listed answers without explanations.

Accept any other relevant and correct answer.

### Section C: The Arctic

Resource C1 shows the Arctic Seasonal Ice Fluctuations between September 2019 and March 2020. Resource C2 shows the average monthly Arctic Sea Ice Extent from 1979 to 2017. Resource C3 shows the Arctic Daily Sea Ice Extent.

- (a)** Study Resource C1. List two countries which have a direct strategic interest in the management of the Arctic's resources. [1 mark]  
*Point marked*  
Suggested answers:  
• USA, Russia, Iceland, Norway, Canada, Greenland, Denmark  
  
Award 0.5 mark for each country identified.
- (b)** Study Resource C1. Describe the changes observed between September 2019 and March 2020. [2 marks]  
*Point marked*  
Suggested answers:  
• Large seasonal fluctuations in sea ice between March (maximum) and September (minimum)  
• The size and extent of sea ice in March covers almost the entire Arctic Ocean surrounding Russia, Canada, Alaska and Greenland. This decreases over the following six-month time period to approximately a quarter of the March sea ice area.  
• Specific spatial patterns of the sea ice changes include ice bound areas in March such as the Bearing Sea, Hudson Bay, Sea of Okhotsk (Eastern Siberia), Beaufort Sea, Baffin Bay, amongst others, becoming ice free in September.  
  
Award 1 mark for each observation. No 0.5 mark awarded.  
  
Accept any other relevant and correct answer.
- (c)** Study Resource C2. Explain two reasons for the pattern shown in Resource 2. [4 marks]  
*Point marked.*  
Suggested answers:  
• Natural factors influencing sea ice extent include: naturally Warming climatic cycle in the Holocene epoch, declining albedo feedback cycle warming the planet = declining ice size and extent. Thinning of the sea ice cover may speed up the declining over time of areas covered by sea ice.  
• Cultural factors influencing sea ice extent include: Anthropogenic climate change; human acceleration of the greenhouse effect, temperature and oceanic warming associated with the above changes.

Award 2 marks for explained reason; award 1 mark for unexplained reason (up to a maximum of 2 unexplained reasons).

Accept any other relevant and correct answer.

- (d) Study Resource C3. Explain why daily sea ice in the Arctic reaches its minimum extent in September.

[2 marks]

*Point marked.*

Suggested answers:

- There is a lag time between the longest daylight months of June/July and their associated inbound radiation/ warming and the gradual warming of the Arctic Ocean and associated sea ice melt.
- Heat capacity of water
- September is only month with above zero temperatures.

Award 2 marks for explained reason. Award 1 mark for unexplained reason.

Accept any other relevant and correct answer.

- (e) “An ice-free Arctic will bring about more positive impacts than negative impacts.” How far do you agree with this statement? Explain your stand.

[6 marks]

*Point marked.*

Suggested answers:

- **Positive effects:**
  - An ice-free Arctic opens up opportunities for resource extraction such as rare metals, natural gas and oil.
  - Provide a shorter shipping/trade route between Europe and Asia/ Pacific
  - Warmer sea and longer periods without sea ice opens up opportunities for more agriculture in especially southern Greenland and other coast near areas for growing vegetables such as potatoes, salad etc
  - More tourism which can bring in tourist dollars and job creation in tourism industry
  - Changes in fishing industry could spur innovation in developing new types of technologies/fishing vessels
- **Negative effects:**
  - Decline of the ice bound habitat of species such as Polar Bears, seals, different fish etc, accelerating extinction in areas and upcoming of new species in area where they might disturb the ecosystem.
  - Possibly increases Geo-Political tensions over new ice-free fishing areas and resource development opportunities.
  - Increased coastal erosion along ice free coasts;
  - Loss of traditional way of life/ food gathering of Inuit/ First Nations Peoples.

- In arctic areas the dependency in wintertime on getting fresh water from cutting ice bergs will decrease due to thinner sea ice not capable of holding a loader tractor
- More tourism can harm the vulnerable ecosystem
- Changes in fishing industry (e.g. need investment in new fishing vessels)

Award 2 marks for each explained impact; award 1 mark for each unexplained impact (up to a maximum of 3 unexplained impacts, i.e. maximum 3 marks). Students must include at least 1 positive or negative impact in answer to score full 6 marks.

Accept any other relevant and correct answer.

## Section D: Cruise Tourism

Resource D1 shows the share of available beds on cruise ships in 2017 by major world regions. Resource D2 shows the trends in cruise tourism in 2018. Resource D3 shows information on passengers in the busiest Mediterranean cruise ports from 2013 to 2017.

- (a) (i)** Study Resource D1. Suggest two characteristics of the Caribbean region which might attract tourists on cruise holidays.

[1  
mark]

*Point marked.*

Suggested answers:

- Relaxing
- Relatively warmer climate
- Beaches
- Tropical landscapes
- Scenic islands/archipelago
- Coral reefs
- Cultural diversity/Latin culture
- Bermuda Triangle

Award 0.5 mark for each precise answer.

Accept any other relevant and correct answer.

- (ii)** Study Resource D1. Suggest two characteristics of the Alaskan region which might attract tourists on cruise holidays.

[1  
mark]

*Point marked.*

Suggested answers:

- Whale watching
- Glaciers
- Scenic coasts
- Winter landscapes/cold climates which attract tourists from warmer climates
- Indigenous culture
- Polar lights
- Polar day
- Effects of climate change (related to melting ice)

Award 0.5 mark for each answer.

Accept any other relevant and correct answer.

- (b)** Study Resource D2. Explain two reasons why North America and Europe are the main source markets of cruise tourism.

[4  
marks]

*Point marked.*

Suggested answers:

- High income – e.g. There is a critical mass of people with rather high income that can afford travelling on cruises.
- Available time – e.g. Better paid jobs and working regulations (particularly in Europe) leave people enough time to travel (as main holiday or short holidays).
- High level of urbanization – e.g. Most people live in crowded cities, often facing pollution and without touch with nature and heritage, which increases their motivation to travel on the sea and visit natural and heritage areas.
- Multiple holidays – e.g. Many frequent holiday makers in Europe and North America have multiple holidays throughout the year, due to high income and excellent air transport connections, with one of them including cruising.
- Diversified supply in cruising tourism – E.g. Ships of various size and equipment, offering tourists different itineraries, themes and level of luxury, depending on their budget (from short party cruises to assisted living cruises).
- Itineraries for all budgets – E.g. diversified itineraries include programs for tourists with different budget for travelling, from inexpensive classic mega-cruises to small luxury yachts.
- All-inclusive holidays where everything is paid at once – E.g. Even non-experienced travellers can travel easy by paying the whole service at once, without having to worry about organizing all segments of their holidays.

Award 2 marks for each explained reason; award 1 mark for unexplained reason (up to a maximum of 2 unexplained reasons).

Accept any other relevant and correct answer.

- (c) In cruise tourism, a home port is a port in which a cruise starts and ends, in which passengers embark and disembark. Explain 4 ways in which a city can become an ideal home port.

[4  
marks]

*Point marked.*

Suggested answers:

- Excellent transport connections by air (and additionally by trains and highways) with potential source markets
- Strategic position in an area with a high tourism demand
- Proximity to large and attractive destinations on the coast and inland
- High tourism supply in the port city for a large number of tourists – accommodation for stays before embarking and/or after disembarking), restaurants, bars, shopping, sightseeing, culture
- Developed urban transport that connects the cruise port with other transport terminals (e.g., airport, train station...)

- Desirable higher concentration of seaports nearby
- Availability of services needed for maintaining the ships (e.g., fuel, repairing, cleaning...)

Award 1 mark for each reason. No 0.5 mark awarded.

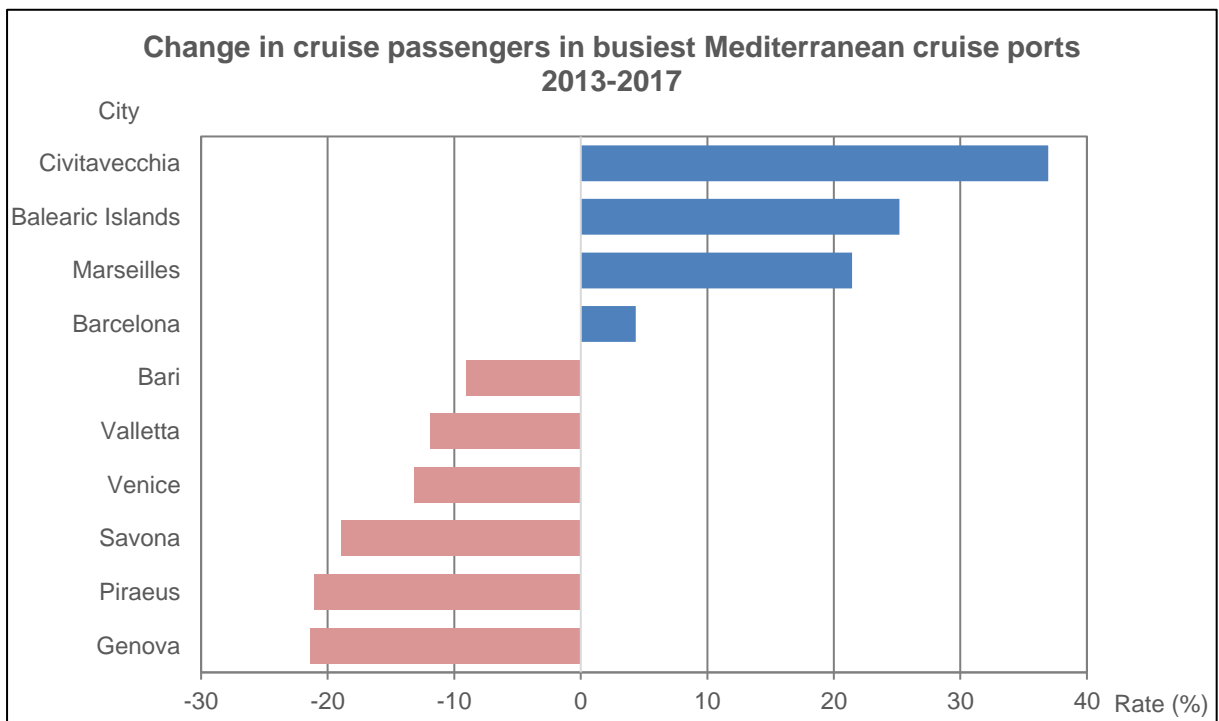
Accept any other relevant and correct answer.

- (d) Study Resource D3. Use an appropriate data representation method to display the rate of change of cruise passengers from 2013 to 2017 (%). You should use the blank page provided in the Answer Booklet for this question.

[5 marks]

*Point marked.*

Suggested answer:



Award 2 marks for appropriate diagram; award 1 mark if student has chosen some sort of positive/negative bar or column diagram. It can be horizontal (as above) with positive and negative x-axis or vertical with positive and negative y-axis. Do not award any marks for any other type of diagram as it is not the most appropriate for the data and a key skill is for students to select the most appropriate type for the data.

Award 2 marks only for a diagram with values ordered from highest to lowest (or vice versa), with no empty space on axes and drawn using a ruler (or precisely by hand).

- 0.5 mark is subtracted if values are not ordered from highest to lowest (or vice versa)
- 0.5 mark is subtracted if there is empty space on x/y axis with no values (i.e. if the axis is longer than needed)



- 0.5 mark is subtracted if the diagram is not drawn using a ruler or very precisely by hand

Award 0.5 marks for each of the following elements that have been drawn correctly:

- 0.5 mark for suitable title (must have reference to cruise passengers and either one of “Mediterranean cruise ports” (where) and/or “2013-2017” (when)).
- 0.5 mark for the names of the cities on the y axis (or x axis on the column diagram). The general label “city” may be omitted. The label “city” can be above the city names or placed vertically to the left.
- 0.5 mark for the label “Rate (%)” on the x axis (or y axis on the column diagram). The label “Rate” may be omitted. The label can be in the same line as numbers or below.
- 0.5 mark for even scale on the axis with the percentage. Intervals of percentage have to be the same for positive and negative values.
- 0.5 mark for expressing positive and negative values in a different way (e.g. different colours of bars/columns for positive and negative values, different colour of values beside the bars/columns etc.).
- 0.5 mark for accurate plotting (check visually a couple of high and low values). Allow for small amounts of rounding to suit the scale.

## Section E: Rivers

Resource E1 shows an idealised model of changes in channel variables along the Sutlej River in North India. Resource E2 shows load size in the Sutlej River. Resource E3 shows a fluvial landform and its fluvial feature. Resource E4 shows a fluvial landform.

- (a)** Study Resource E1. Describe the downstream changes in the channel variables. [2 marks]  
*Point marked.*  
Suggested answers:
- Gradient decreases downstream
  - Mean velocity increases downstream
  - Mean channel depth increases downstream
  - Mean channel width increases downstream
  - Normal stream discharge increases downstream
- Award 2 marks for all 5 descriptions, 1.5 mark for 4 descriptions, 1 mark for 3 descriptions, 0.5 mark for 2 descriptions and 0m for 1 description.
- Accept any other relevant and correct description.
- (b)** Study Resource E1. Give reasons for the downstream changes in the channel variables. [2 marks]  
*Point marked.*  
Award 0.5 mark for each of these (max 2 marks):
- Either of these:
    - Vertical distance vs horizontal distance (ie straight channels vs meanders) affect gradient
    - Change of relief (steep to flat) as river moves downstream decreases gradient
  - Inflow from tributaries increases width and/or depth (as they are separate lines in the graph) and/or discharge
  - Erosion increases width and/or depth
  - Channel smoothness/roughness increases velocity
  - Width and depth (channel shape/efficiency) increases velocity and/or discharge.
- (c)** Study Resource E2. Explain how load size can affect the types of fluvial transportation processes present in the Sutlej River. [3 marks]  
*Point marked.*  
Suggested answer:

- When energy levels are very high, large rocks and boulders can be transported. When energy levels are low, only small particles can be transported (if any).
- Coarser boulders and cobbles transported via **traction** which involves large boulders and rocks rolling along the river bed.
- Pebbles and gravel will be transported via **saltation** which involves small pebbles and stones bouncing along the river bed.
- Sand, silt and clay will be transported via **suspension** which involve fine, light material being carried along in the water.

Award 1 mark for each fluvial transportation method (in bold above) if mentioned correctly with the appropriate type of load size. Award 1 mark if student explains the effect of varying levels of river energy (as seen in the first bullet point above).

- (d) (i) Study Resource E3. Identify the fluvial feature identified as 'RF'.

[1 mark]

*Point marked.*

Suggested answer:

- Oxbow lake

Award 1 mark for answer. No 0.5 mark awarded.

- (ii) Study Resource E3. Explain the formation of this fluvial landform and its feature 'RF'.

[4 marks]

*Point marked.*

Award marks as suggested.

Suggested answer:

- Depositional features such as riffles in a channel increases friction due to the presence of coarser materials and shallower waters. This reduces efficiency as energy is lost to overcome the friction.
- The river hence tries to flow around the riffles. This causes **the thalweg** to move towards the opposite bank. This flow increases the turbulence in the river and results in **helicoidal flow**, which is a corkscrew like motion that is instrumental in the process of meandering. (0.5 mark for mentioning both thalweg and helicoidal flow)
- **At the outer bank, there are deeper waters and higher velocity.** The high energy here results in the **lateral undercutting of the bank due to erosion** processes such as hydraulic action and abrasion. (0.5 mark for mentioning erosion at outer bank)
- This creates a **concave shape and a steep river cliff (or river bluff)**. (0.5 mark for mentioning river cliff)
- The helicoidal flow then moves the sediment from the **outer bank to the inner bank where the river is much shallower and slower. Deposition hence occurs** here, forming a convex shape. Sediment deposits are sorted, with

coarser sediments nearer to the base of the slopes. (0.5 mark for mentioning deposition at inner bank)

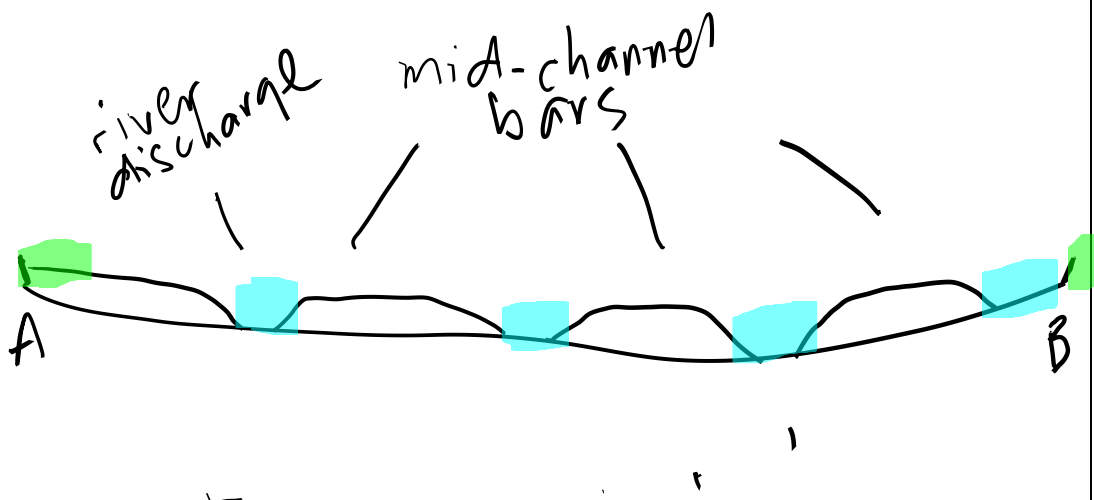
- The deposits here accumulate to form **slip-off slope or point bar**. (0.5 mark for mentioning slip-off slope or point bar)
- The end result is an asymmetrical channel cross section where the slope is gentler on the convex bank and steeper on the concave bank.
- Continued erosion and deposition along the river causes the meander to migrate both laterally and downstream. The **meanders may also become more sinuous**. The deposition of alluvial sediment also results in aggradation on the floodplain. However, this may be confined in some meanders due to the presence of rocky outcrops or resistant valley walls, and also human structures like bridges or roads. (0.5 mark for mentioning that meanders can become more sinuous/migrates laterally)
- As erosion on the concave banks and deposition on the convex banks continue, **the neck of land between two meanders narrow**. Over time, this **neck of land is cut through** by lateral erosion or strong currents of high discharge during a flood. (0.5 mark for mentioning narrow neck of land which gets cut through)
- The river continues to take this new, shorter and straighter route and the meander loop called a cutoff is created. Eventually, **ongoing deposition on the banks of the channel seals off the cutoff from the river channel creating an ox bow lake**. The lake then dries up slowly, leaving behind a meander scar. (0.5 mark for cutoff is sealed off to form ox-bow lake)

(e) Study Resource E4. Sketch and annotate the cross section 'AB' as shown in Resource E4. You should use the blank page provided in the Answer Booklet for this question.

[3 marks]

*Point marked.*

Suggested answer:



# 1 title - Cross-section AB of Boarded River

Award 1m for each of this which must be labelled:

- Mid-channel bars
- River discharge

Award 0.5m each of these:

- Labelled 'A' and 'B' on ends of the diagram
- Title of the sketch