Section A

Cluster 1: Development, Economy and Environment

1 Resource 1 depicts world electricity generation from 2000 to 2020. Resource 2 shows the distribution of water from the Nile River Basin and rate of dependence on the water flow of the Nile River Basin by country. Resource 3 is a map of the Nile River Basin and its riparian states. Of the 11 riparian states of the Nile River Basin, Egypt and Sudan are considered as downstream riparian states. Resource 4 depicts the average annual rainfall in the Nile River Basin. Resource 5 is an article about the usage of the Nile River water by Ethiopia and Egypt.

(a) With reference to Resource 1, describe the trends in world electricity generation from 2000 to 2020. [5]

Possible pointers:

- In general, world electricity generation increased from 2000 to 2020 [1 mark], from 15 million gigawatt hours to 27.5 million gigawatt hours [1 additional mark].
- World electricity generation from clean fuels increased at a faster rate as compared to fossil fuels. [1 mark] Over the span of 20 years, world electricity generation from clean fuels doubled, from 5 million to 10.5 million gigawatt hours. However, in the same time period, world electricity generation only increased by a third from 10 million 10 million to 16.5 million gigawatt hours [1 additional mark].
- World electricity generation from all energy sources saw an increase save for nuclear energy and oil and other fossil fuels. [1 mark]
- Unlike all other sources, wind and solar fuel sources did not contribute to world electricity generation in 2000, but contributed to 4 million gigawatt hours of electricity generation by 2020. [1 mark]

(b) Explain the trade-offs associated with the use of hydropower. [6]

Possible pointers:

Economic	
Desirable outcome	**Trade-off**
Hydropower reduces reliance on imported fuels that carry the risks of price volatility, supply uncertainty and foreign currency requirements. **Hydropower also helps to meet electricity demands** for industrial and economic purposes.	**Adverse effects on agriculture in areas near the dam & its reservoir:** Local heightening of water tables following reservoir impoundment can contribute to water-logging and salinization, which negatively affects crops. **Adverse impact on fisheries downstream:** Dams can adversely affect marine and fish populations, disrupting fisheries. • E.g. Sediment and nutrients trapped behind dams leads to reduced nutrient load downstream, etc. **Adverse impact on aquaculture and agriculture downstream:** The reduced flow of water downstream encourages saline intrusion into coastal regions. This can have a devastating impact on aquaculture and agriculture.
Environmental	
Desirable outcome	**Trade-off**
Hydropower can combat climate change as an alternative energy source.	**Ecosystem impacts due to creation of a reservoir:** The creation of a reservoir results in the loss of biodiversity in the land area being inundated. **Exacerbating climate change:** Reservoirs trapped behind dams can also affect global climate by contributing to emissions (methane and CO2) that intensify global warming. The "fuel" for these emissions is the rotting of organic matter from the vegetation and soils flooded when the reservoir is first filled. **Increased sedimentation resulting in loss of land & ecosystem impacts:** Sediment trapped behind dams leads to reduced sediment load downstream. The clear water below the dam is said to be “sediment-hungry” and it will seek to recapture its sediment load by eroding the bed and banks of the river.
Social	
Desirable outcome	**Trade-off**
Protect lives through flood control: Dams and reservoirs can be effectively used to regulate river levels and flooding downstream of the dam by temporarily storing the flood volume and releasing it later. **Recreation:** Reservoirs can provide prime recreational facilities such as boating, fishing, swimming etc.	**Displacement of communities:** Big dams often displace inhabitants of the area to be inundated, and the numbers of people involved can be very large. **Loss of cultural property and identity:** Beyond the loss of land, fisheries and food security, communities may also lose their cultural identity as these inundated locations may hold special cultural significance. **Diseases may thrive due to impoundment.** E.g. Malaria may increase since mosquitos transmitting the disease breed in standing waters. **Lack of food security downstream:** Adverse impacts on fisheries and agriculture downstream can severely impact food security for riparian communities.

(c) With reference to Resource 2, compare the distribution of water from the Nile River Basin and the rate of dependence on the water flow for the Nile Basin for Egypt and Ethiopia**.** [4]

Possible pointers:

Egypt	Basis of Comparison	Ethiopia
Generally similar to Ethiopia – moderate distribution of water from Nile River Basin at 9% compared to other countries.	**Distribution of water from Nile River Basin**	Generally similar to Egypt – moderate distribution of water from Nile River Basin at 11.5% compared to other countries.
Much higher – Egypt has a high dependence of water flow from Nile River Basin at 96.9%	**Rate of dependence on the water flow**	Much lower – Ethiopia has a low dependence of water flow from Nile River Basin at less than 5%

(d) With reference to Resource 3, describe the distribution of dams on the Nile River Basin. [4]

Possible pointers:

- Dams are concentrated only in less than half of the riparian states of the Nile River Basin. [1 mark] 5 of the 11 riparian states of the Nile River Basin have dams – Uganda, Kenya, Sudan, Ethiopia and Egypt. [1 additional mark]
- Dams are found in both upstream and downstream riparian states. [1 mark]
- However, most of the dams are concentrated in the downstream riparian states in Sudan and Egypt [1 mark]. Of the 12 dams constructed in the Nile River Basin, 8 dams are found in the downstream riparian states of Egypt and Sudan while only 4 are found in the upstream riparian states. [1 additional mark]

(e) Using information from Resources 3, 4, and 5, explain why the construction of the Grand Ethiopian Renaissance Dam might result in conflict between Egypt and Ethiopia. [7]

Possible pointers:

The construction of the Grand Renaissance Dam might cause water flow to Egypt to be reduced. [1 mark]

- From Resource 3:
    - As seen from Resource 3, the location of the Grand Renaissance Dam is upstream of the 4 dams in Egypt's territory, and hence once the dam is in operation, it might possibly result in reduced water flow for downstream states like Egypt which need the water [1 mark].

This might therefore result in conflict between Egypt and Ethiopia as the reduction of water flow to Egypt would severely impact it, due to Egypt's heavy reliance on the water flow from the Nile River. [1 mark]

- From Resource 4:
    - Egypt experiences very arid conditions as shown by how it is located in the subtropical arid hot desert climate zone (BWh) [1 mark], showing that the supply of water from sources outside of the Nile River Basin is rather low. [1 additional mark]
- From Resource 5:
    - In particular, Egypt's population is heavily reliant on water from the Nile River Basin for economic survival [1 mark], as seen in Resource 5 where it says that the agricultural sector which "employs about a quarter of the population and supports the livelihoods of nearly a quarter more". [1 additional mark]
    - Egypt is also reliant on the Nile River for electricity for domestic needs and industrial purposes [1 mark], as seen in Resource 5 where it is said that "water from the Nile is also used to fill Lake Nasser, the reservoir for Egypt's own hydro-electric power plant, the Aswan High Dam". [1 additional mark]

The conflict might also worsen / continue as Ethiopia too requires the dam for economic growth: [1 mark]

- From Resource 5:
    - From Resource 5, it can be seen that the dam would ensure that the electricity needs for its population and business development to happen. Currently, the dam is meant to ensure electricity generation for "60% of its population who currently have no supply" and "provide businesses with constant electricity supplies" to support economic growth. [1 mark]

(f) Suggest **two** ways in which countries like Egypt and Ethiopia could manage conflicts due to transboundary water resources. [4]

Possible pointers:

- **Bilateral water agreements** - legal documents, signed by all affected countries that establish clear guidelines for cooperation and the sharing of water as well as measures to deal with conflict.

- **Third-party mediation** – used when a negotiation over use or conflicts over transboundary water sources reaches an impasse; the third party (whether a person, group, representative of a state, or an international organisation) aids the disputants to reach a mutually agreed solution.

- **Hydro-wars** – armed conflict as a way to resolve disputes and conflicts over water use and water resource allocation.

Cluster 2: Tropical Environments

2 Resource 6 shows a weathered rock which contains iron. Resource 7 shows a limestone region in Jamaica.

Resource 8 shows the relationship between rainfall characteristics and the occurrence of debris flows. Resource 9 shows a schematic diagram of factors leading to the development of a mass movement.

(a) With reference to Resource 6, account for the likely weathering process that the rock has undergone. [4]

Possible points:

- Likely weathering process – oxidation (1m).
- Resource 6 indicates that the weathered rock contains iron and the photo shows that the top surface of the rock has turned brown/reddish brown (1m).
- The iron in the rock is likely to have combined/reacted with oxygen (from the atmosphere or dissolved oxygen in water) (1m) to form a mineral (usually weaker) of a higher oxidation state, such as ferric oxide which is insoluble and has a striking brown/reddish brown colour (1m).

(b) Within reference to Resource 7, explain how the features of the limestone region shown may have developed. [6]

Possible points:

- Resource 7 shows a cone and cockpit karst landscape, which comprise a succession of conical hills separated by star-shaped enclosed depressions (dolines) called cockpits (1m).
- Limestone is primarily composed of calcium carbonate ($CaCO_3$), and this is highly soluble when in contact in contact with carbonic acid (e.g. rainwater with dissolved carbon dioxide) and facilitates the action of the key weathering processes of carbonation and solution. (1m)
- Due to high rainfall (typical of tropical areas), intense carbonation and solution processes take place (1m), particularly at the intersection of the joints and fractures on limestone surfaces. This causes closed depressions (dolines) to form on the surface of the exposed limestone (1m).
- The dolines are further widened and deepened by intense dissolution processes due to the presence of organic acids from the decomposition of dense vegetation growth (1m).
- Over time, neighbouring dolines may expand and merge with one another, to form a network of enlarged dolines. (1m)
- As these dolines continue to expand and merge from various sides, a series of low residual hills (marking the boundary of these combined dolines) will eventually be formed between them. (1m)
- Over time, these low hills are rounded (by weathering processes) into regularly-spaced conical/cone-shaped hills (cones), producing cone karst. (1m)

(c) Explain how climatic factors may influence weathering of rocks**.** [6]

Possible points:

- **Role of temperature**:
  - Temperatures that fluctuate around temperature extremes tend to facilitate physical weathering processes (1m).
    - For instance, thermal weathering requires a large diurnal range of temperature required for alternation of expansion and contraction cycles to occur (1 additional mark). Freeze-thaw action requires temperatures to fluctuate above and below the freezing point of water such that the alternating freezing and thawing cycles allows for physical stresses to be set within the rock/along lines of weaknesses (1 additional mark).
  - For chemical weathering, temperature governs the rate of chemical reactions (1m).
    - Generally, the higher the temperature, the faster the rate of chemical reactions. According to Van't Hoff's rule, the rate of chemical reactions approximately doubles with every increase of 10°C (1 additional mark).

- **Role of rainfall**:
  - Water facilitates the setting up of physical stresses within rocks and is thus necessary for some physical weathering processes to take place (1m).
    - E.g. Freeze-thaw action: Water needed for ice wedges to form
    - E.g. Salt weathering: Water carries the dissolved salts to the surface
  - Water is a key agent for many chemical weathering processes to take place as it plays the role of a catalyst (reactant), solvent and in acid production (1m).
    - E.g. As seen in the processes of hydrolysis, carbonation, and solution (1 additional mark)

- Climate can also indirectly influence weathering of rocks through its impact on **vegetation growth**.
  - Generally, high temperatures and high rainfall will encourage the growth of vegetation and organisms that can then facilitate both physical and weathering processes. (1m)
  - E.g. Roots of plants forcing into lines of weakness of rocks will widen and deepen them, allowing water to infiltrate more easily (1m). This facilitates chemical weathering processes where water is a key agent, and physical weathering processes such as freeze-thaw action. (1 additional mark)
  - E.g. The canopy and foliage of trees helps in retaining soil moisture, thus promoting chemical reactions and hence chemical weathering. (1 additional mark)

(d) With reference to Resource 8, explain how rainfall characteristics could influence the occurrence of debris flows. [6]

Things to note:

- *Award 1 mark for each explanation of how rainfall characteristics may influence the occurrence of debris flows*
- *Award 1 additional mark for further development of each explanation, where applicable.*
- *Award a maximum of 4 marks for explanation of rainfall intensity or rainfall duration.*

Possible points:

- Resource 8 shows that debris flows can occur when rainfall intensity and rainfall duration is above a particular (rainfall) threshold / will not occur below a particular (rainfall) threshold (1m).

- **Role of rainfall intensity**:
  - Debris flows can occur at high rainfall intensity (even with shorter rainfall duration)(1m).
  - High rainfall intensity increases the likelihood of Hortonian overland flow which could lubricate the surface between the slope materials on the surface and the slope (1 additional mark), hence lowering friction/ shear strength which increases the chance of slope instability/the occurrence of debris flows (1 additional mark).

- **Role of rainfall duration:**
  - Debris flows can also occur with relatively longer rainfall duration (even at relatively lower rainfall intensity) (1m).
  - Extended rainfall is likely to eventually saturate slope materials leading to increased pore water pressure (1m) which lowers the cohesiveness and hence shear strength of slope materials (1 additional mark).
  - In addition, the water content also increases the weight of slope materials, increasing the influence of the tangential force of gravity on the slope materials/ shear stress (1 additional mark).

(e) With reference to Resource 9, account for the likely mass movement that might develop. [4]

Possible points:

- The likely mass movement that will occur in the context shown on Resource 9 is a rotational slide/slump (1m).
- Resource 9 shows the presence of a relatively more permeable soil layer and pervious layer of severely cracked bedrock overlying an impervious layer of bedrock with few cracks (1m).
- As such, after a rainfall event, water is able to infiltrate into the soil layer and layer of cracked bedrock, and move laterally downslope (1m).
- However, as the water in unable to permeate/percolate into the resistant bedrock below, the water accumulates/concentrates at the base of the slope (1m), which serves to lubricate the contact point between the overlying slope materials and impervious bedrock, lowering friction and shear strength, hence leading to rotational slide (1m).
- The rainfall is likely to also have added weight to the overlying slope materials, hence increasing the influence of the tangential force of gravity on the slope materials/ shear stress (1m).
- The curved nature of the resistant bedrock surface at the base of the slope also accounts for the occurrence of a rotational slide/slumping (1m).

(f) Explain how human factors may influence mass movements on slopes. [4]

Possible points:

- Human factors can contribute both directly and indirectly to the reduction of shear strength and addition of shear stress to slopes (1m).

- **Head loading** – This occurs when additional weight is placed on a slope, often through the dumping of waste material or the emplacement of fill for house or road construction (1m). This may increase the shear stress on the slope, and also increase the slope angle, hence increasing the influence of the tangential force of gravity on the slope (1 additional mark).

- **Road construction on slopes** (1m) increases shear stress as the cut-slope exceeds the angle of repose, hence increasing the influence of the tangential force of gravity on the slope (1 additional mark). In addition, excavation of material to facilitate road building also reduces shear strength as the cohesiveness of slope material is reduced (1 additional mark).

- **Use of machinery** (1m) can causes shocks and vibrations that result in slope material losing cohesion, thereby reducing shear strength (1 additional mark).

- **Deforestation** (1m) causes slope material to be loosened due to the loss of soil binding by roots, thus reducing shear strength of the slope (1 additional mark).

- On the other hand, human activities can also lower the occurrence of mass movement through **slope stabilisation techniques** (1m) which can help to increase the shear strength of a slope:
    - E.g. Soil nailing / Rock nailing: Drilled steel bars can be installed on a regular grid pattern to secure and stabilise existing slopes. (1 additional mark)
    - E.g. Rock fall netting: A drapery system designed to control rockfall movement by guiding falling debris to a collection point at the base of the slope. (1 additional mark)

Section B

Answer **either** question 3 **or** question 4, and answer **either** question 5 **or** question 6.

Cluster 1 Development, Economy and Environment

3 Evaluate the effectiveness of strategies to manage the effects of extractive industries. [20]

Possible Approaches:

- Candidates could approach the question by making a judgement on the extent to which strategies to manage the effects of extractive industries are effective through the use of criteria such as:
    - **Comprehensiveness** of strategy in tackling BOTH environmental and socio-economic effects of extractive industries
    - Strategy's ability to tackle the **root cause** of impacts of extractive industries (which could differ depending on the nature of impact, OR some might even argue that environmental issues are the root cause of some social impacts like impacts on human health)
    - Feasibility of strategy to manage effects of extractive industries (e.g. how financially feasible a strategy is)
    - How sustained the effects of the strategy is (e.g. can the strategy be maintained over a long period of time? is the strategy a stop-gap measure only?)

- Candidates could also consider the context of the country – e.g. level of development, etc. – with the understanding that context might be important in determining the effectiveness of the strategy.

- Candidates could also consider the possible trade-offs that might occur with the implementation of the strategy, and the degree of acceptability of these trade-offs.

Levels marked using Generic Level Descriptors for H2 essays

4 Evaluate the view that labour has little influence over economic activities. [20]

Possible Approaches:

- Candidates could approach the question by making a judgement on whether labour has a significant influence on economic activities through a consideration of the relative influence of labour vis-à-vis other actors such as states, transnational corporations and multilateral institutions. The validity of the view could be assessed by **comparing the relative influence of actors** using criteria such as:
    - Effect on nature of economic activities within the local economy
        - E.g. changes in the structure of the local economy – shifts to manufacturing or services sector.
        - E.g. diversity of the local economy – limited (perhaps due to low educational/skills level of labour) vs high (where labour is highly employable in a variety of sectors)
    - Effect on global flows of capital or locational decisions of TNCs
    - Effect on global flows of trade

- Candidates could also analyse the influence of labour unions on TNCs and states and the degree to which TNCs and states can exert an impact/regulate labour.

- Candidates could also approach the question by making a judgement on whether labour have a greater influence on economic activities in some contexts than others through a consideration of two or more case studies. Candidates could analyse the contextual factors such as the level of development and the nature of the economic activities, which may have contributed to the differences in the influence of labour.

Levels marked using Generic Level Descriptors for 20m H2 essays.

Cluster 2 Tropical Environments

5 Evaluate the influence of monsoon circulation on rainfall in the tropics. [20]

Possible Approaches:

- Candidates could approach the question by making a judgement on the influence monsoon circulation on rainfall in the tropics as compared to other factors such as: Hadley cells (global-scale atmospheric circulation), tropical cyclones (as a part of synoptic-scale atmospheric circulation), and ENSO (synoptic-scale atmospheric circulation), using criteria such as
    - Being the root factor that influences rainfall amount and seasonality in the tropics
        - E.g. It is argued that the key driving factor for rainfall amount and seasonality in the tropics is the Hadley Cells
    - Spatial scale at which the factor operates at
        - E.g. Monsoons, ENSO and tropical cyclones operate at a smaller scale or over a smaller area than the Hadley Cells
    - Temporal scale at which the factor operates at
        - E.g. Impact of Hadley Cells experienced all the time vs. more seasonal factors such as monsoons, ENSO and tropical cyclones

- Consideration of the context could also be weaved into response:
    - E.g. Certain countries / regions would be more greatly impacted by certain factors due to geographical conditions / location – e.g. Am climate zones primarily affected by monsoon circulation

Levels marked using Generic Level Descriptors for H2 essays.

6 "The formation of fluvial landforms in the humid tropics are solely determined by fluvial processes."

Evaluate this statement. [20]

Possible Approaches:

- Candidates could approach the question by making a judgement on whether the formation of fluvial landforms are solely determined by fluvial processes through a consideration of the validity of this statement in relation to how it:
    - Comprehensively addresses/accounts for the range of fluvial landforms along the long profile of a river – e.g. meandering channels, braided channels and deltas.
    - Accurately addresses/accounts for the distinct morphology/ variations in specific categories of landforms – e.g. river-dominated vs tide-dominated vs wave-dominated deltas
    - Comprehensively address/accounts for all factors that could contribute to the formation of fluvial landforms, beyond the processes – e.g. the role of discharge regime, sediment regime and channel flow.

- Candidates could also approach the question by making a judgment on whether some factors or processes have a greater influence in some contexts than others through a consideration of two or more case studies.

Levels marked using Generic Level Descriptors for H2 essays