

CITY UNIVERSITY OF HONG KONG

Course code & title : SEE1003: Introduction to Sustainable Energy and Environmental Engineering

Session : Semester B 2021/22

Time allowed : Two hours

This paper has SIX pages (including this cover page).

1. This paper consists of 10 questions in 1 section.
 2. Answer ALL questions in Section A.
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*This is an **open-book** examination.*

Students are allowed to use the following materials/aids:

- a. Notes, books and internet resources*
- b. Calculator*

Materials/aids other than those stated above are not permitted. Students will be subject to disciplinary action if any unauthorized materials or aids are found on them.

Section A (100%)

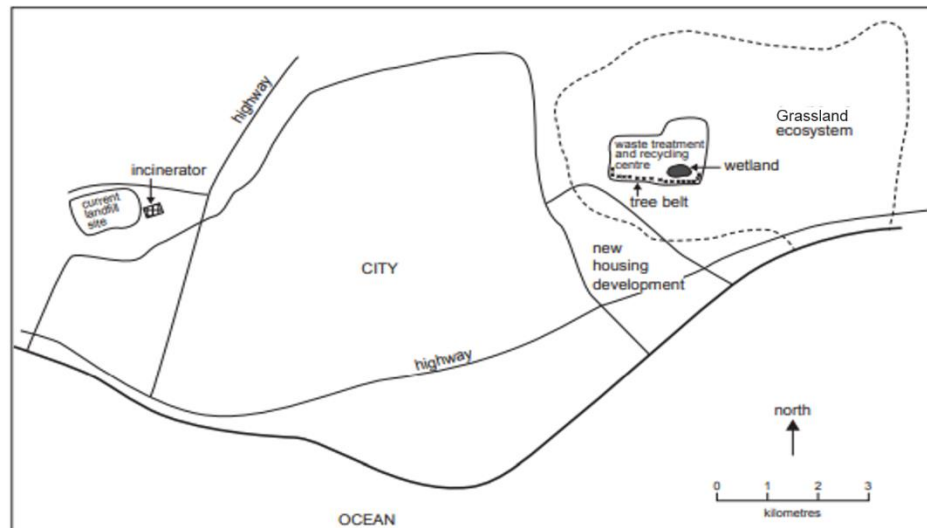
Attempt ALL questions from this Section

1. Many ocean creatures use calcium carbonate (CaCO_3) to make their shells or to make the reef material where coral animals live. When algae die, their organic material becomes part of the ocean sediments, which may stay at the bottom of the ocean for many and many years. Over millions of years, those same ocean sediments can be forced down into the mantle when oceanic crust is consumed in deep ocean trenches.
As the ocean sediments melt and form magma, one type of gas is eventually released while volcanoes erupt and come into the atmosphere.
 - 1.a. So, which type of gas it could be and which biogeochemical cycle it may complete? (2 points)
 - 1.b. This gas when dissolved in seawater can react with water molecules to release H^+ ions. What is the impact of this process on Hong Kong's marine life? (2 points)
2. A waste-management company has purchased land to the north-east of the city, with the intention of building a major waste treatment and recycling facility. The land is currently covered by a grassland ecosystem with a small area of wetland. Most locals have little to do with the area and some complain that it is 'just a mosquito-infested swamp'. Minimal environmental investigation has been conducted at the site. However, preliminary research has identified the wetland as a possible habitat for multiple species for intertidal crabs.

This new waste treatment and recycling plant will replace the current landfill system, where for the last 20 years waste has been dumped and buried in an old quarry to the west of the city. Some types of waste are also incinerated at this location. The landfill site has enough space to last for another three years. Twenty workers will lose their jobs when this site is closed down.

The construction of the proposed facility will cost approximately \$16 million and the facility will require 50–60 employees on-site when it becomes fully operational. The sale of recycled materials, such as glass, steel, paper, aluminium, other metals and organic garden compost, is predicted to result in an overall profit of \$1.3 million per year. The facility will require an upgrade of roads, water services, the sewerage system and electricity in the region. Approximately 67% of the grassland will be cleared on-site and the wetland will be drained. The proposal includes the planting of a screening belt of non-indigenous trees, designed to hide the facility from the view of residents in the newly built housing estate. People in the housing estate have concerns about the noxious odours, dust and noise that may be produced by the new facility, and worry that vermin (such as rats) may be attracted by the waste to the area.

It is planned that trucks will transport material to and from the site, 16 hours a day



- 2.a In the table below, summarise the major arguments for and against the proposal, identifying key social and economic factors. (4 points)

	For	Against
Social Factors		
Economic Factors		

- 2.b A key part of the Environmental Impact Assessment report will be a focus on the environmental advantages and disadvantages of the proposal. Discuss the major environmental considerations relevant to the proposal, and based on these points only, evaluate whether the proposal should be given permission to proceed or not. (4 points)
- 2.c When making the final decision regarding the approval of the proposal, the government will also need to consider the economic and social aspects of the proposal. Explain why. (2 points)
3. Electric vehicles (EVs) have been introduced to consumers as an alternative way to reduce the environmental effects caused by use of internal-combustion engine (ICE) vehicles. A comparison of both vehicle types can help determine whether the use of EVs would be beneficial in the future. Where calculations are required, show your work.

- 3.a The charger supplies energy to the EV battery at an average rate of 7.0 kilowatts (kW) and fully charges the EV battery in 8.0 hours. The car will run for 480 km on a full charge. The cost of electricity is HK\$1.13 per kilowatt-hour (kWh).
- Calculate the cost of the electricity to fully charge the battery. Assume that the battery is not charged to begin with. (2 points)
 - Calculate the cost of electricity per mile to drive the EV. (2 points)

When it is driven 480 km, the ICE vehicle contributes 33 kg of CO₂ from the burning of the gasoline. The drilling, refining, and transportation costs of getting the gasoline to the gas station add an additional 8.02 kg of CO₂ per 480 km. The EV does not emit any CO₂ itself, but the extraction, transportation, and combustion of the coal that produced the electricity at the power plant emit 28.8 kg of CO₂ per 100 miles of EV operation. (You can take 1 mile = 1.6 km)

- 3.b Calculate the difference in the amount of CO₂ that would enter the atmosphere if both cars were driven 100 miles. (3 points)
- 3.c Describe TWO environmental impacts (excluding CO₂ emissions) that result from an increased number of EVs on the road. (4 points)
- 3.d Identify TWO strategies that the government has/could implement to encourage the use of EVs. (4 points)

4. Take the following data as referring to 2000 (they come from UNDP (2001), population size (P) and per capita activity or affluence (A) are for 1999 and emissions per unit production (T) uses CO₂ data for 1997), and the world as being the sum of these three groups of nations.

	Population (millions)	Activity per capita (PPP US\$)	Technology (tonnes of CO ₂ per US\$)
Rich OECD	848	26 050	0.0004837
EE and CIS	398	6 290	0.0011924
Developing	4610	3 530	0.0005382

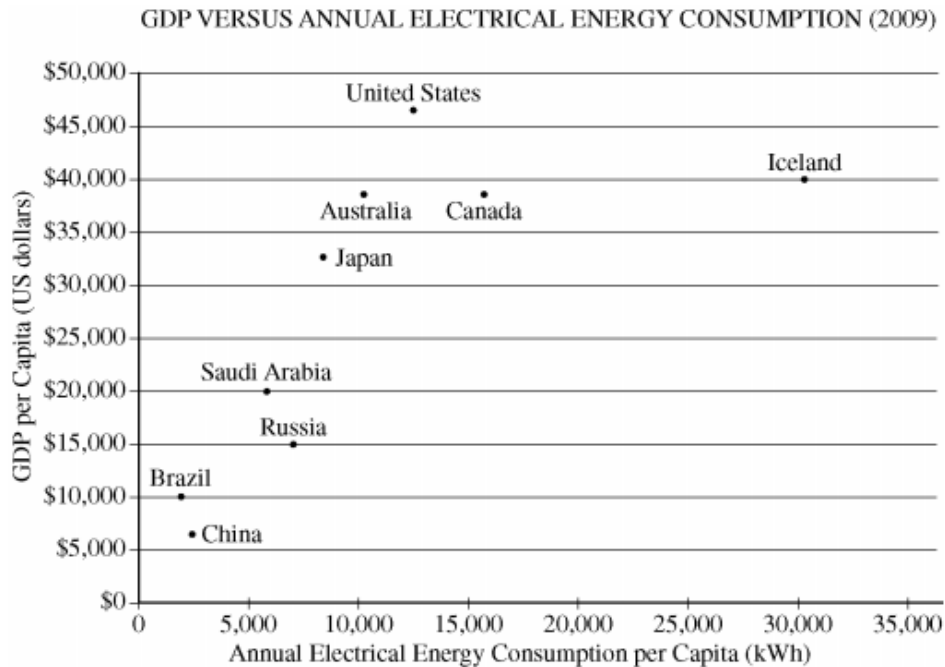
- 4.a Calculate total world CO₂ emissions in 2000. (3 points)
- 4.b Work out the share of total population and CO₂ emissions for the three different groups in 2000. (2 points)
- 4.c Assume population growth at 0.5% per year in Rich OECD and EE and CIS and at 1.5% per year in Developing, out to 2050. Assume per capita income growth at 1.5% per year in Rich OECD, at 2.5% per year in EE and CIS, and at 3.0% in Developing, out to 2050. Work out total world emissions and share of emissions for each group in 2050, and the total world population and share of population for each group in 2050. (5 points)

- 4.d For the same population growth and per capita income growth assumptions as given in the previous sub-question, by how much would T have to fall in Rich

OECD for that group's 2050 emissions to be the same as in 2000? With this new T for Rich OECD in 2050, assume that T for EE and CIS in 2050 achieve same level of T for Rich OECD in 2000 and work out what total world CO₂ emissions would then be. (5 points)

5. Name and explain the three processes of energy transfer of solar radiation on its way out of the atmosphere. (6 points)
6. The spread and continued growth of urban areas presents a number of concerns for a sustainable future. Nowadays, urban residents have been aware of the challenges their cities are facing on the way to sustainability.
 - 6.a Please discuss THREE common challenges faced by Hong Kong specifically? (6 points)
 - 6.b Please identify the FOUR key sectors that are responsible for Hong Kong's ecological footprint. (2 points)
7. You are part of an engineering team who are standing 10 meters from 2 jet aircrafts on the ground to test their engines. Each of their sound pressure level is 140 dB, which is the threshold of pain. Now you feel uncomfortable and want to move further away from the aircraft and work remotely so that the sound pressure level is a lower value of 85 dB.
 - 7.a How far from the aircrafts do you need to be? (please show your calculation) (4 points)
 - 7.b The team leader then provides earmuffs to all of the engineers. If you keep working remotely in the distance (where SPL = 80 dB), do you need to wear the earmuffs. Explain your reasoning with scientific knowledge. (3 points)
 - 7.c Name THREE negative health impacts caused due to very high noise levels? (3 points)

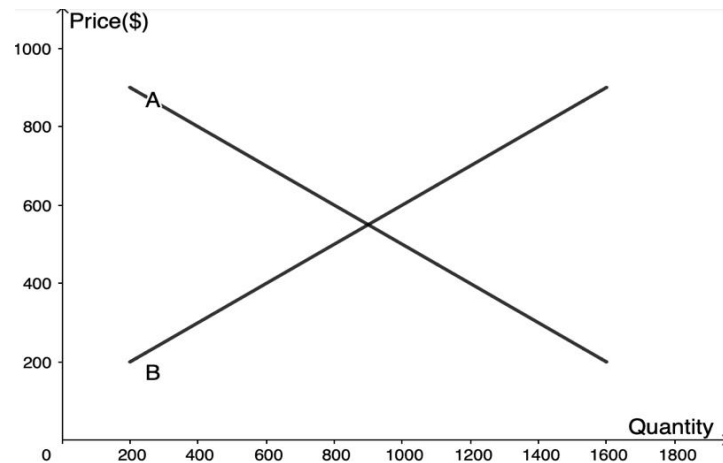
8. Shown below is a graph of the gross domestic product (GDP) per capita versus the annual electrical energy consumption per capita for nine countries in 2009.



- 8.a Iceland's position on the graph is due in part to its access to geothermal energy sources. Describe how electricity is generated from a geothermal source. (3 points)
- 8.b Despite its low GDP per capita and low annual electrical energy consumption per capita, China has become the world's largest emitter of CO₂. Explain this apparent contradiction. (3 points)
- 8.c In addition to contributing to increased atmospheric CO₂ concentrations, China is facing other air pollution issues related to the generation of electricity. Identify TWO of the issues and describe the impacts they have on human health. (6 points)
- 8.d Two countries shown on the graph have developed domestic energy sources: *sugarcane in Brazil* and *tar sands in western Canada*.
- Choose EITHER sugarcane or tar sands, then briefly describe the process of fuel production from that energy source. (1 point)
 - Describe TWO disadvantages of using the energy source that you chose in part (d)(i) (2 points)
 - Which of the two energy sources is more sustainable? Justify your answer with an explanation. (2 points)

9. One type of feedback loop is associated with a signal to stop and another is associated with a stimulus to produce more. Which is the positive feedback loop and which is the negative, and give two examples of each? (6 points)

10. A company identifies the Supply and Demand Curves of a commodity which are indicated in the below figure.



- 10.a WHICH curve is supply curves (A or B)? and WHY? (2 points)
- 10.b What is the quantity and the price when economy is at equilibrium. (2 points)
- 10.c If the commodity does cause environmental damage at an extra social cost of about \$300, please PLOT the social supply curve to take the externality into account in the figure and estimate the new equilibrium quantity from the social perspective. (4 points)

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