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Diploma Programme
Programme du diplôme
Programa del Diploma

Environmental systems and societies
Standard level
Paper 2

Monday 1 November 2021 (morning)

Candidate session number

2 hours

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[65 marks]**.

23 pages

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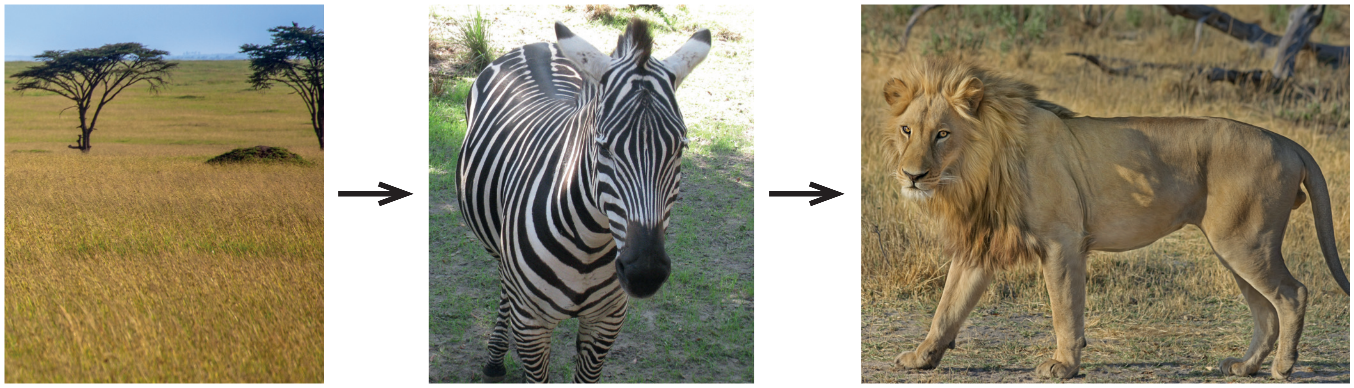
Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

Figure 1(a): Savanna food chain



Savanna grassland

Zebra

Lion

1. (a) (i) State the trophic level of the zebra. [1]

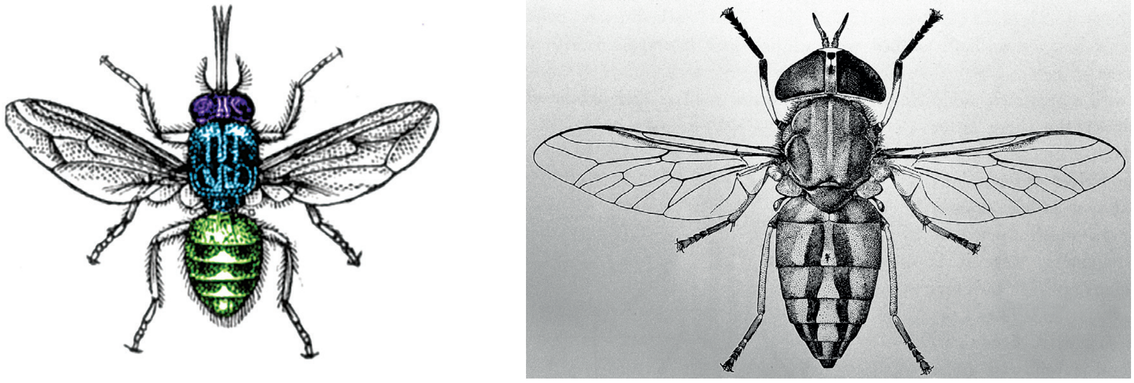
(ii) State how you could determine gross secondary productivity of the zebra. [1]

(iii) Explain how the second law of thermodynamics applies to this food chain. [2]

(This question continues on the following page)

(Question 1 continued)

Figure 1(b): Biting flies in the savanna



Biting flies bite and drink the blood of zebras. They commonly carry diseases that can be fatal to zebras.

(b) State the type of relationship that exists between biting flies and the zebra. [1]

(c) Zebra stripes may reduce the ability of the biting flies to land on the zebra. Describe how natural selection may have led to the evolution of zebra stripes in response to biting flies. [3]

2. An area of temperate coniferous forest was deforested and allowed to regenerate. A survey of species numbers was conducted in three successional stages. The results of the survey are summarized in **Table 1**.

Table 1: The number of organisms found in each successional stage for selected species

	Number of organisms in each successional stage		
Species	*Early*	*Intermediate*	*Late*
Red huckleberry (*Vaccinium parvifolium*)	100	80	70
Western hemlock (*Tsuga heterophylla*)	0	20	60
Douglas fir (*Pseudotsuga menziesii*)	50	132	90
Keen's mouse (*Peromyscus keeni*)	80	96	90
Douglas squirrel (*Tamiasciurus douglasii*)	5	30	40
American pine marten (*Martes americana*)	0	2	10
Total number of organisms	235	360	360
Simpson's diversity index (*D*)	2.94	3.80	---

(a) Referring to the data in **Table 1**, calculate the Simpson's diversity index (*D*) of the late successional stage (show your working). [2]

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

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(b) Define *species diversity*. [1]

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(This question continues on the following page)

(Question 2 continued)

(c) Explain why the diversity changes in the different successional stages. [2]

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Figure 2: Keen's mouse was found in all three successional stages

(d) (i) State **one** method to determine the population size of the Keen's mouse. [1]

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(ii) Identify **two** factors that could impact the accuracy of the method stated in 2(d)(i). [2]

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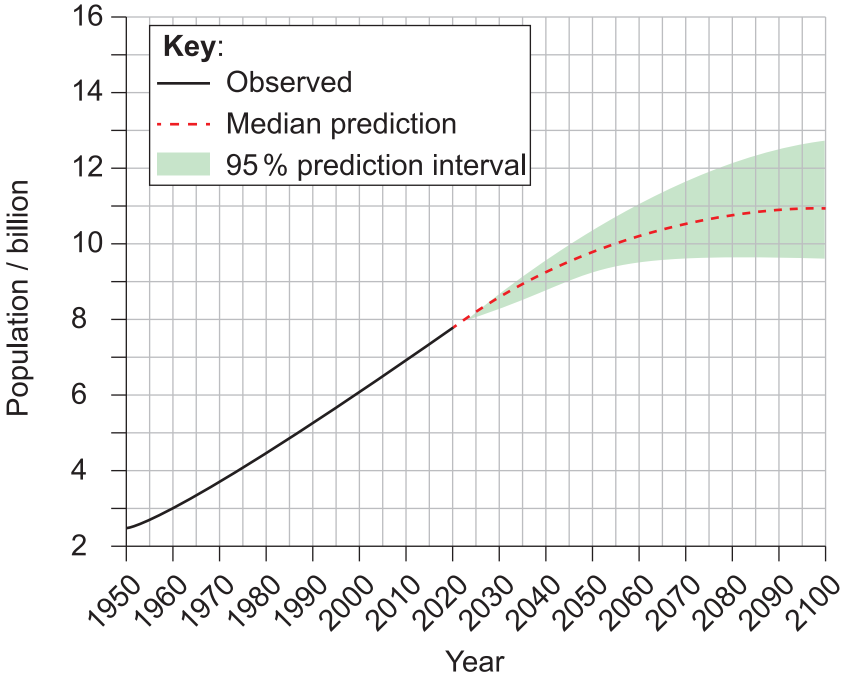
Figure 3(a): World population figures 1950–2019 and predictions 2020–2100



3. (a) (i) Using **Figure 3(a)**, identify the year in which the median prediction of the world population will reach 10 billion. [1]

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(ii) Outline **one** reason for the uncertainty in predicting the world's population in **Figure 3(a)**. [1]

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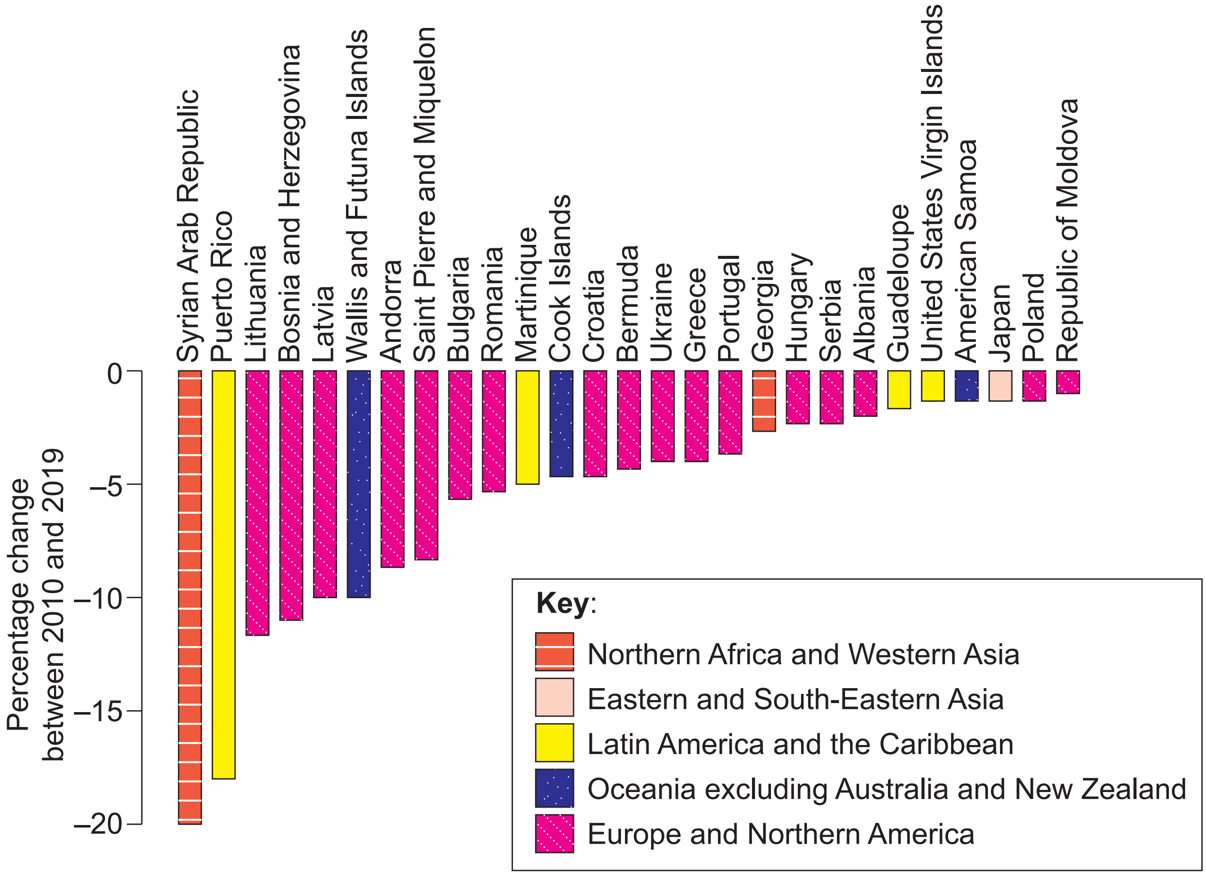
(Question 3 continued)

Figure 3(b): Countries and regions where population decreased by at least one per cent between 2010 and 2019



(b) (i) Using **Figure 3(b)**, identify the region that has the most countries with a decrease in the percentage change in population between 2010 and 2019. [1]

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(ii) Outline **two** factors that could contribute to a reduction in population in the countries in **Figure 3(b)**. [2]

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(Question 3 continued)

(c) Discuss how a country’s stage in the demographic transition model (DTM) might influence its national population policy. [4]

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Section B

Answer **two** questions. Answers must be written within the answer boxes provided.

4. (a) Identify **four** factors that make the use of the insecticide DDT controversial. [4]

(b) Explain how human activities continue to affect stratospheric ozone. [7]

(c) To what extent is the use of solid domestic waste (SDW) as an energy source beneficial to a society? [9]

5. (a) Outline **one** method for measuring the impact of a build-up of dead organic matter in an aquatic ecosystem. [4]

(b) Explain how models of ecosystems might be used in species conservation. [7]

(c) Discuss how the introduction and re-introduction of a species can affect an ecosystem. [9]

6. (a) Outline the albedo effect and its role in regulating the Earth's global temperature. [4]

(b) Compare and contrast the adaptation strategies to climate change for **two** societies. [7]

(c) Discuss whether biodiversity loss or climate change is a greater threat to human societies. [9]

7. (a) Identify **four** strategies that can be used in the sustainable management of wild fisheries. [4]

(b) Evaluate the sustainability of **two** water management strategies to improve access to freshwater resources in a society. [7]

(c) To what extent can the different environmental value systems improve the sustainability of food production? [9]

References:

Figure 1(a) Djsudermann, 2019. [*Elephants in the Savannah*] [image online] Available at: https://pixabay.com/photos/elephant-trees-savannah-sky-animal-4121954/ [Accessed 29 September 2020]. Source adapted.

designerpoint, 2012. Lion-wildcat-safari-africa-515030. [image online] Available at: https://pixabay.com/photos/lion-wildcat-safari-africa-515030/ [Accessed 3 September 2020].

Figure 1(b) [*Tsetse fly*] 2006. [image online] Available at: https://commons.wikimedia.org/wiki/File:Tsetse_fly.png [Accessed 22 May 2020]. Source adapted.

Wellcome Material: Tropical Medicine, 2014. Illustration of ‘Tabinus socius’. [image online] Available at: https://commons.wikimedia.org/wiki/File:Illustration_of_%27Tabinus_socius%27;_Tropical_Medicine_Wellcome_L0025345.jpg. Second report of the Wellcome Research Laboratories at the Gordon Memorial College, Khartoum / Andrew Balfour. https://wellcomecollection.org/works/ez3txjfg. Attribution 4.0 International (CC BY 4.0) https://creativecommons.org/licenses/by/4.0/deed.en [Accessed 22 May 2020]. Source adapted.

Figure 2 Stuart Wilson / Biosphoto / Alamy Stock Photo.

Figure 3(a) United Nations, 2019. World Population Prospects 2019. [image online] Available at: https://population.un.org/wpp/Graphs/Probabilistic/POP/TOT/900 © 2019 United Nations, DESA, Population Division. Licensed under Creative Commons license CC BY 3.0 IGO. https://creativecommons.org/licenses/by/3.0/ United Nations, DESA, Population Division. World Population Prospects 2019. https://population.un.org//wpp/ [Accessed 22 May 2020]. Source adapted.

Figure 3(b) United Nations, 2019. *World Population Prospects 2019 Highlights*. [PDF online] Available at: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf. Copyright © 2019 by United Nations, made available under a Creative Commons license (CC BY 3.0 IGO) http://creativecommons.org/licenses/by/3.0/igo [Accessed 29 September 2020]. Source adapted.