

© International Baccalaureate Organization 2022

All rights reserved. No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without the prior written permission from the IB. Additionally, the license tied with this product prohibits use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organisation du Baccalauréat International 2022

Tous droits réservés. Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organización del Bachillerato Internacional, 2022

Todos los derechos reservados. No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Environmental systems and societies
Standard level
Paper 2

Monday 31 October 2022 (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]**.



Section A

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

- The family *Leporidae* includes hares and rabbits. The figures show four species that can be found in western North America.

Figure 1(a): Four species of the family *Leporidae*

Species A: Length 55–66 cm



Species B: Length 35–40 cm



Species C: Length 46–63 cm



Species D: Length 25–29 cm



Figure 1(b): A dichotomous key for species A to D

- | | | | |
|----|----|---|--|
| 1. | a. | Less than 30 cm in length | pygmy rabbit (<i>Brachylagus idahoensis</i>) |
| | b. | Greater than 30 cm in length | go to 2 |
| 2. | a. | Has black tail | black-tailed jackrabbit (<i>Lepus californicus</i>) |
| | b. | Has a mostly white tail | go to 3 |
| 3. | a. | Has short rounded ears | Nuttall's cottontail (<i>Sylvilagus nuttallii</i>) |
| | b. | Has ears at least 2.5 times as long as wide | white-tailed jackrabbit (<i>Lepus townsendii</i>) |

(This question continues on the following page)



24EP02

(Question 1 continued)

(a) Use **Figures 1(a)** and **1(b)** to identify Species B and Species C.

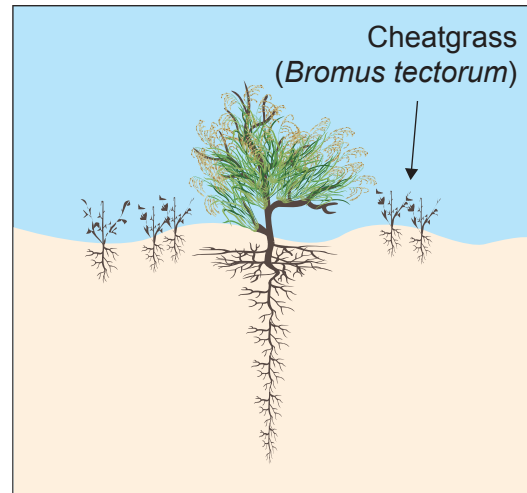
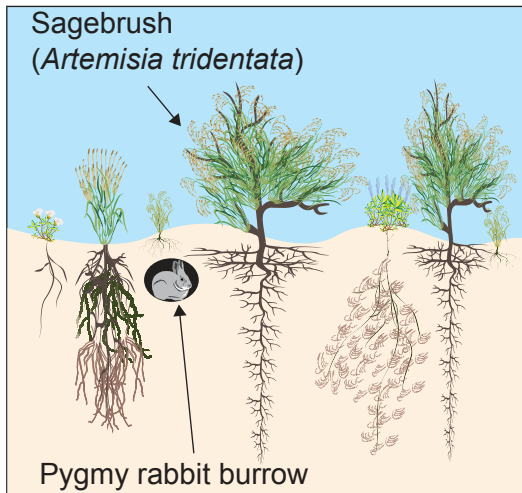
[2]

Species B:
Species C:

Figure 1(c): Sagebrush ecosystem without invasive cheatgrass

Figure 1(d): Sagebrush ecosystem with invasive cheatgrass

Figures not to scale



(b) The sagebrush ecosystem provides a habitat for pygmy rabbits. Suggest **one** reason why there might be a greater number of pygmy rabbits in the ecosystem shown in **Figure 1(c)** than in the ecosystem shown in **Figure 1(d)**.

[1]

.....

(This question continues on the following page)



24EP03

Turn over

(Question 1 continued)

(c) Describe **one** method to determine the impact of invasive cheatgrass on sagebrush density.

[3]

.....

.....

.....

.....

.....

.....

(d) Distinguish between the biodiversity of the sagebrush ecosystems in **Figures 1(c) and 1(d)**.

[2]

.....

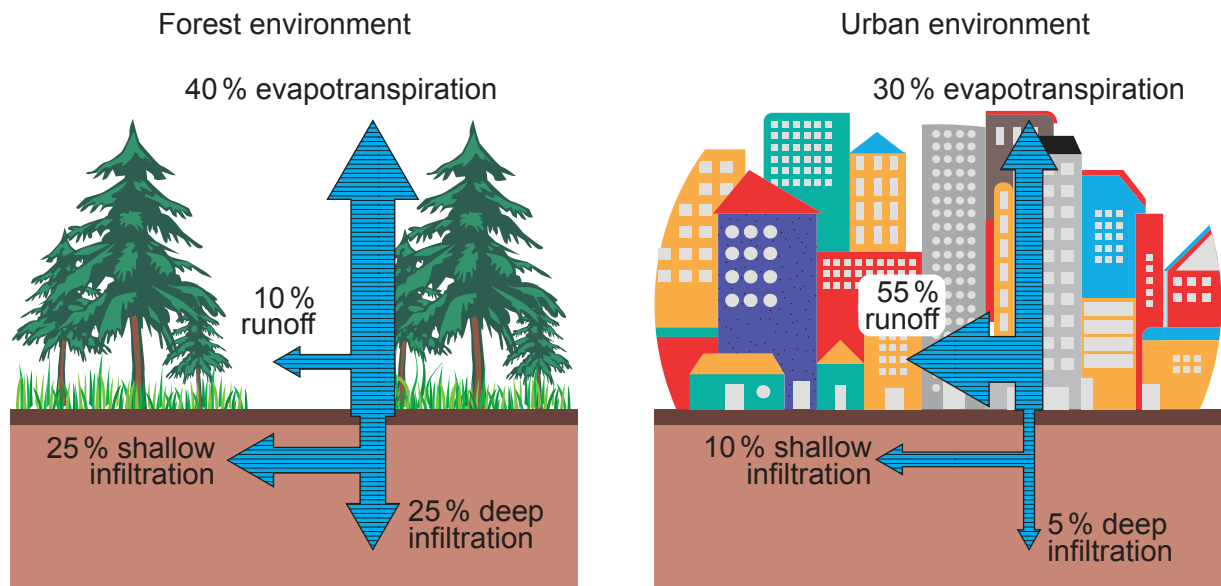
.....

.....

.....



Figure 2(a): Water transfers and transformations after rainfall in forest and urban environments



2. (a) Identify **one** transformation shown in **Figure 2(a)**. [1]

.....

.....

(b) Calculate the difference in water infiltration between the forest and urban environments. [1]

.....

.....

(c) Outline how **one** storage in the hydrological cycle decreases with urbanization. [1]

.....

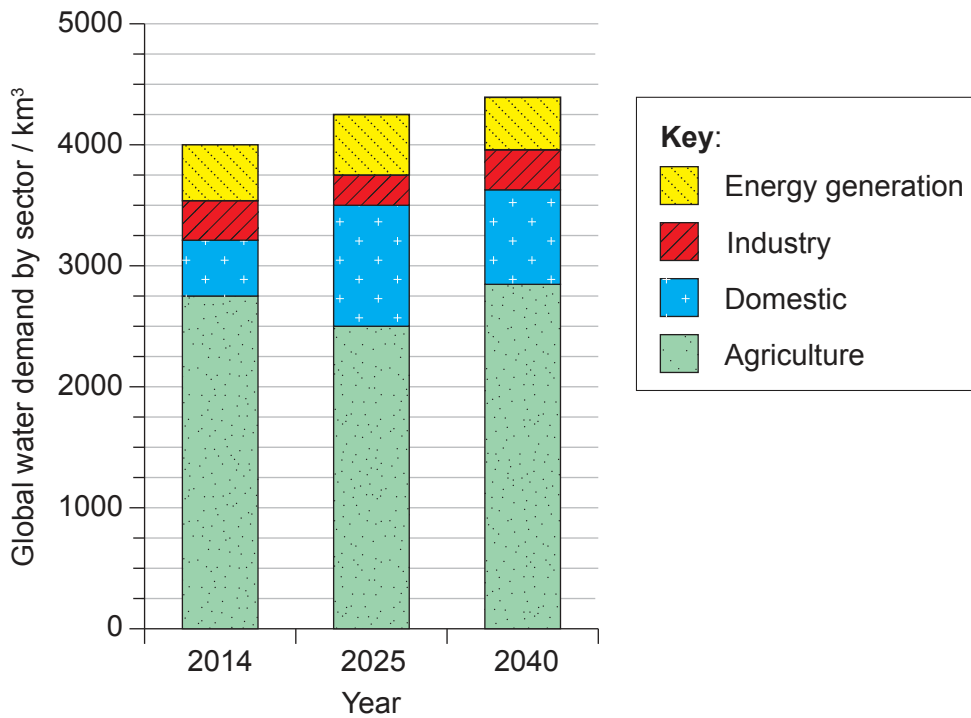
.....

(This question continues on the following page)



(Question 2 continued)

Figure 2(b): Global water demand by sector for 2014, and projected for 2025 and 2040



(d) Calculate the percentage of water projected to be used for agriculture in 2025, shown in **Figure 2(b)**.

[1]

.....

.....

(e) Suggest **one** reason for the projected decrease in the demand for water in agriculture between 2014 and 2025, shown in **Figure 2(b)**.

[1]

.....

.....

(This question continues on the following page)



(Question 2 continued)

- (f) Outline **two** reasons why water demand shown in **Figure 2(b)** is projected to increase globally from 2014–2040. [2]

.....

.....

.....

.....

- (g) Outline **two** strategies to meet an increasing demand for domestic water. [2]

.....

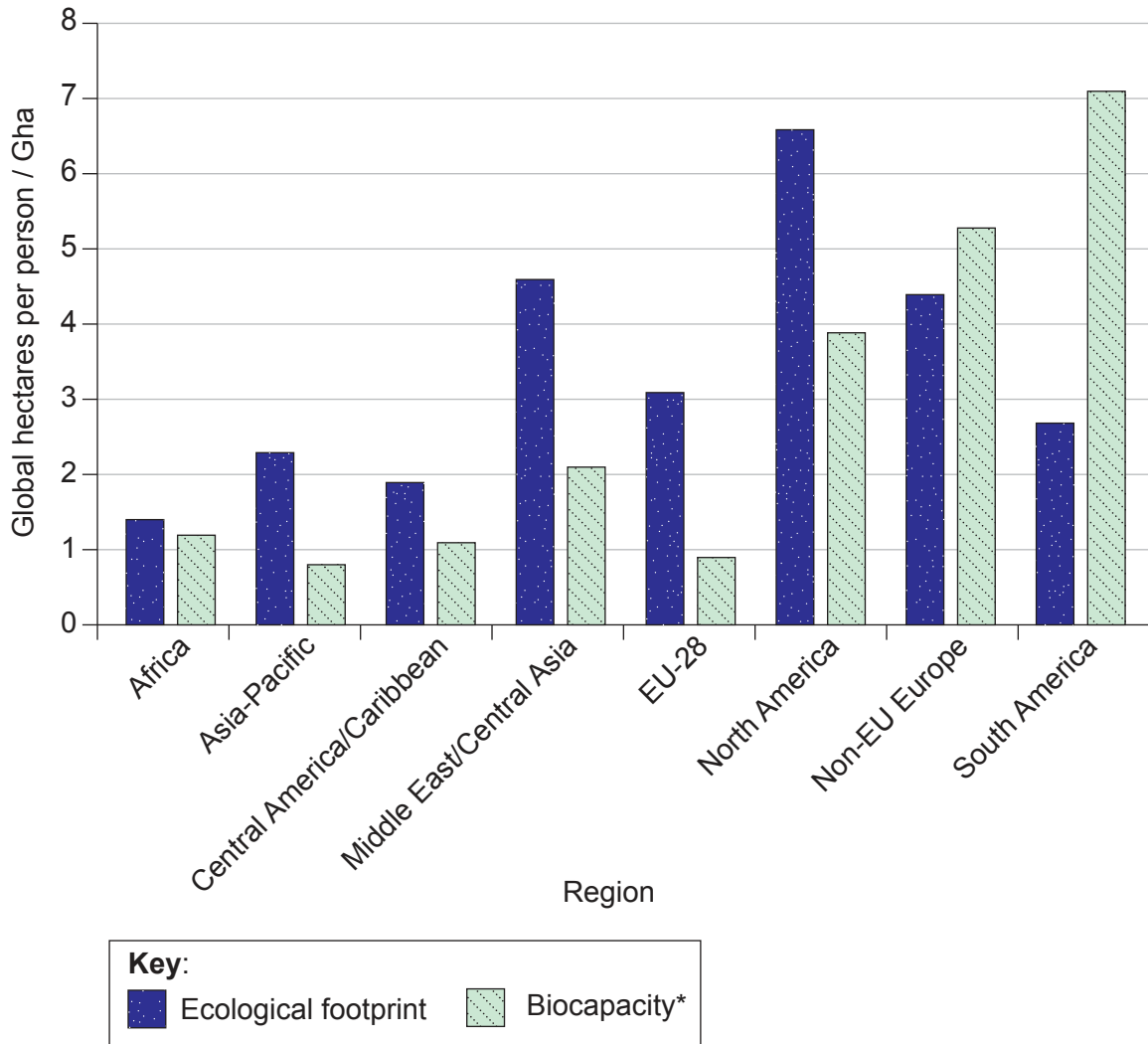
.....

.....

.....



Figure 3: The ecological footprint and biocapacity* for selected world regions, 2016



*Biocapacity: amount of biologically productive land, measured in total hectares per person

3. (a) Identify **one** region shown in **Figure 3** that has an ecological footprint less than its biocapacity. [1]

.....
.....

- (b) Outline **one** reason why a region whose ecological footprint is greater than its biocapacity is considered unsustainable. [1]

.....
.....

(This question continues on the following page)



(Question 3 continued)

(c) Outline **one** way in which a region can exceed its carrying capacity. [1]

.....
.....

(d) Productivity contributes to the biocapacity of land. Outline **one** climatic factor that limits the primary productivity of a region. [1]

.....
.....

(e) Evaluate the use of the ecological footprint as a model. [4]

.....
.....
.....
.....
.....
.....
.....
.....



Section B

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

4. (a) Distinguish between point and non-point sources of pollution with reference to **named** examples. [4]
- (b) For a **named** water pollutant, evaluate **two** management strategies to maintain the sustainability of water sources. [7]
- (c) Human activities have improved global air quality during the past 50 years. With reference to examples, discuss this statement. [9]
5. (a) Describe biotic and abiotic factors with reference to a **named** ecosystem. [4]
- (b) Using a system diagram, explain the transfer and transformation of energy as it flows through an ecosystem. [7]
- (c) With reference to **named** societies, to what extent do environmental value systems influence the use of resources? [9]
6. (a) Outline the role of the greenhouse effect in regulating the temperature on Earth. [4]
- (b) Using examples, evaluate **two** solid domestic waste disposal strategies as methods to mitigate climate change. [7]
- (c) Using examples, discuss the potential impacts of climate change on ecosystem services. [9]
7. (a) Outline the mechanism of natural selection. [4]
- (b) Explain the link between soil fertility, primary productivity and human activity. [7]
- (c) Using examples, discuss how social, cultural, political and economic factors influence societies in their choice of food production systems. [9]



A large rectangular area containing 25 horizontal dotted lines for writing.



24EP11

Turn over

A large rectangular area containing 24 horizontal dotted lines, intended for writing.



24EP12

A large rectangular area containing 24 horizontal dotted lines for writing.



24EP13

Turn over

A large rectangular area containing 24 horizontal dotted lines, intended for writing.



24EP14

A large rectangular area containing 24 horizontal dotted lines for writing.



24EP15

Turn over

A large rectangular area containing 24 horizontal dotted lines, intended for writing.



24EP16

A large rectangular area containing 24 horizontal dotted lines for writing.



24EP17

Turn over

A large rectangular area containing 24 horizontal dotted lines, intended for writing.



24EP18

A large rectangular area containing 24 horizontal dotted lines for writing.



24EP19

Turn over

A large rectangular area containing 25 horizontal dotted lines for writing.



24EP20

A large rectangular area containing 24 horizontal dotted lines for writing.



24EP21

Turn over

A large rectangular area containing 24 horizontal dotted lines for writing.



24EP22

A large rectangular area containing 24 horizontal dotted lines, intended for writing.



24EP23

Disclaimer:

Content used in IB assessments is taken from authentic, third-party sources. The views expressed within them belong to their individual authors and/or publishers and do not necessarily reflect the views of the IB.

References:

- Figure 1(a)** Nuttall's Cottontail (*Sylvilagus nuttallii*). Public domain image by Justin Wilde. [https://commons.wikimedia.org/wiki/File:Nuttall%27s_Cottontail_\(Sylvilagus_nuttallii\).jpg](https://commons.wikimedia.org/wiki/File:Nuttall%27s_Cottontail_(Sylvilagus_nuttallii).jpg).
- Pygmy Rabbit (*Brachylagus idahoensis*) - Photo Public Domain by Beth Waterbury, Idaho Fish and Game. <https://idfg.idaho.gov/species/taxa/17243>.
- White tailed jackrabbit 0140530. Image by Connormah. https://commons.wikimedia.org/wiki/File:White_tailed_jackrabbit_20140530.jpg. Under copyright and licensed under the Creative Commons Attribution-Share Alike 2.0 Generic license. <https://creativecommons.org/licenses/by-sa/2.0/deed.en>.
- Jackrabbit2 crop. Image by Jim Harper. https://commons.wikimedia.org/wiki/File:Jackrabbit2_crop.JPG. Under copyright and licensed under the Creative Commons Attribution-Share Alike 2.5 Generic license. <https://creativecommons.org/licenses/by-sa/2.5/deed.en>.
- Figure 2(a)** U.S. Environmental Protection Agency, Washington, D.C., 2003. *Relationship between impervious surfaces and surface runoff*. [online] Available at: https://en.wikipedia.org/wiki/Stormwater#/media/File:Natural_&_impervious_cover_diagrams_EPA.jpg [Accessed 10 September 2020].
- Figure 2(b)** International Energy Agency (2016), *Water Energy Nexus: Excerpt from the World Energy Outlook 2016*, IEA. Licence: Creative Commons Attribution CC BY-NC-SA 4.0. Based on data from International Energy Agency (2016), as modified by International Baccalaureate Organization.
- Figure 3** Global Footprint Network, n.d. Free public data set. [online]. Data used to create ecological footprint and biocapacity graph. Available at: <https://www.footprintnetwork.org/licenses/public-data-package-free/>. Under copyright and licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. <https://creativecommons.org/licenses/by-sa/4.0/>.

All other texts, graphics and illustrations © International Baccalaureate Organization 2022



24EP24