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Environmental systems and societies
Standard level
Paper 2

30 October 2023

Zone A morning | **Zone B** morning | **Zone C** morning

Candidate session number

2 hours

Instructions to candidates

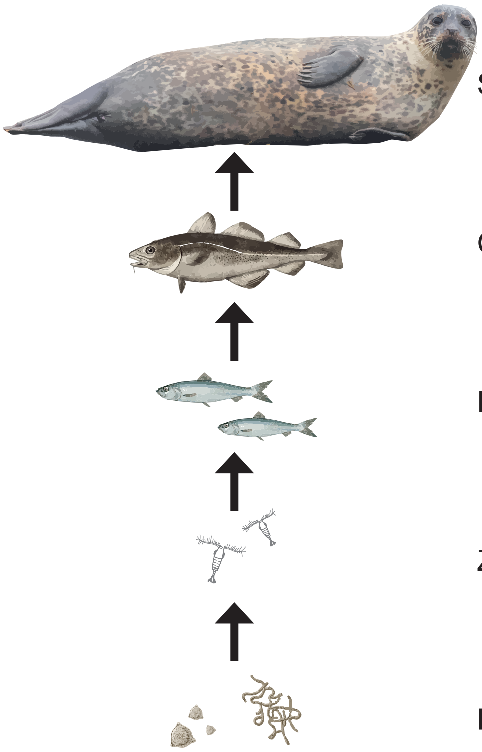
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark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

23 pages

Section A

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

Figure 1: A sample food chain from a marine ecosystem to show the concentration of persistent organic pollutants (POPs) and the energy within each trophic level



	POPs concentration ($mg\ L^{-1}$)	**Energy ($J\ m^{-2} yr^{-1}$)**
Seal	160	1
Cod	110	5
Herring	35	25
Zooplankton	10	500
Phytoplankton	8	20 000

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

(b) State the relationship between POPs concentration and trophic level. [1]

(This question continues on the following page)

(Question 1 continued)

(c) Explain the relationship between POPs concentration and trophic level. [2]

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(d) Calculate, as a percentage, the efficiency of energy transfer between zooplankton and herring. [1]

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(e) Outline **one** strength **and one** weakness of a pyramid of productivity as a model to represent energy in an ecosystem. [2]

Strength: . . . .

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Weakness: . . . .

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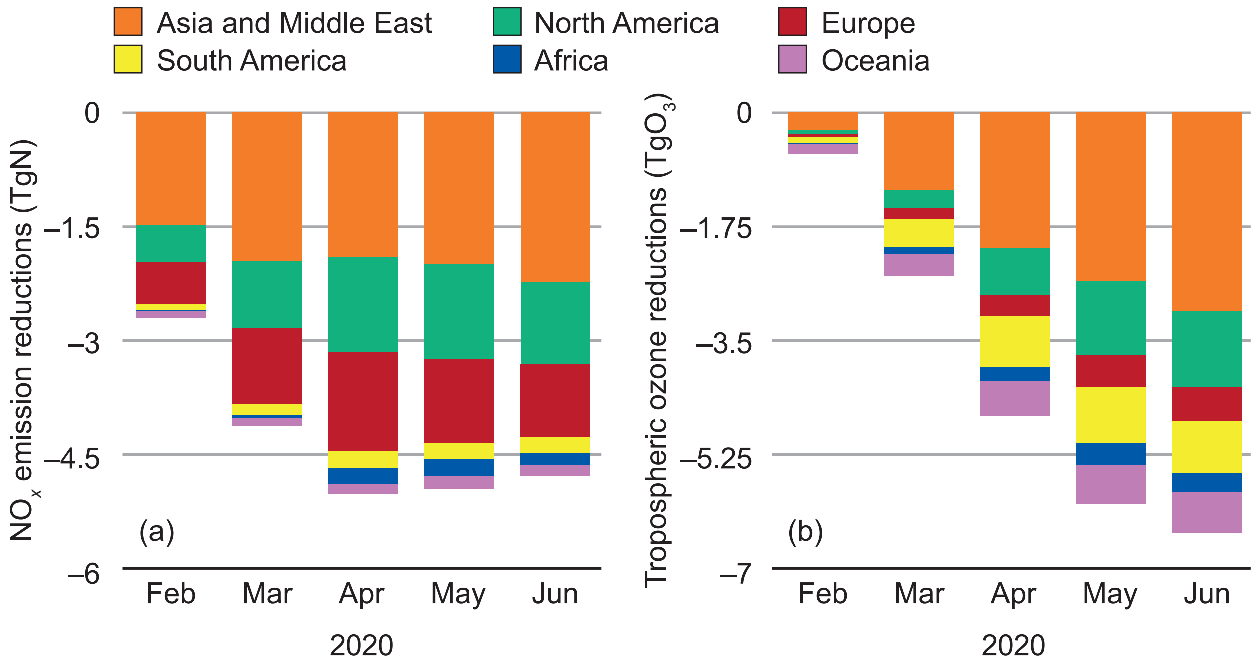
Figure 2: Mean monthly regional changes due to the 2020 COVID-19 lockdowns in (a) oxides of nitrogen (NO_x) emissions and (b) tropospheric ozone (TgO_3)



2. (a) Using **Figure 2(a)**, identify the month in which NO_x emissions in Asia and Middle East has the greatest reduction. [1]

(b) Outline **one** reason for the NO_x emission reductions during COVID-19 lockdowns, as shown in **Figure 2(a)**. [1]

(c) Explain the relationship between the NO_x emissions shown in **Figure 2(a)** and the tropospheric ozone concentrations shown in **Figure 2(b)**. [2]

(This question continues on the following page)

(Question 2 continued)

(d) Outline **two** pollution management strategies to reduce tropospheric ozone. [2]

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(e) NO_x also contributes to acid deposition. Outline **two** impacts of acid deposition on living systems. [2]

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(f) State **one** method that could be used to restore an ecosystem damaged by acid deposition. [1]

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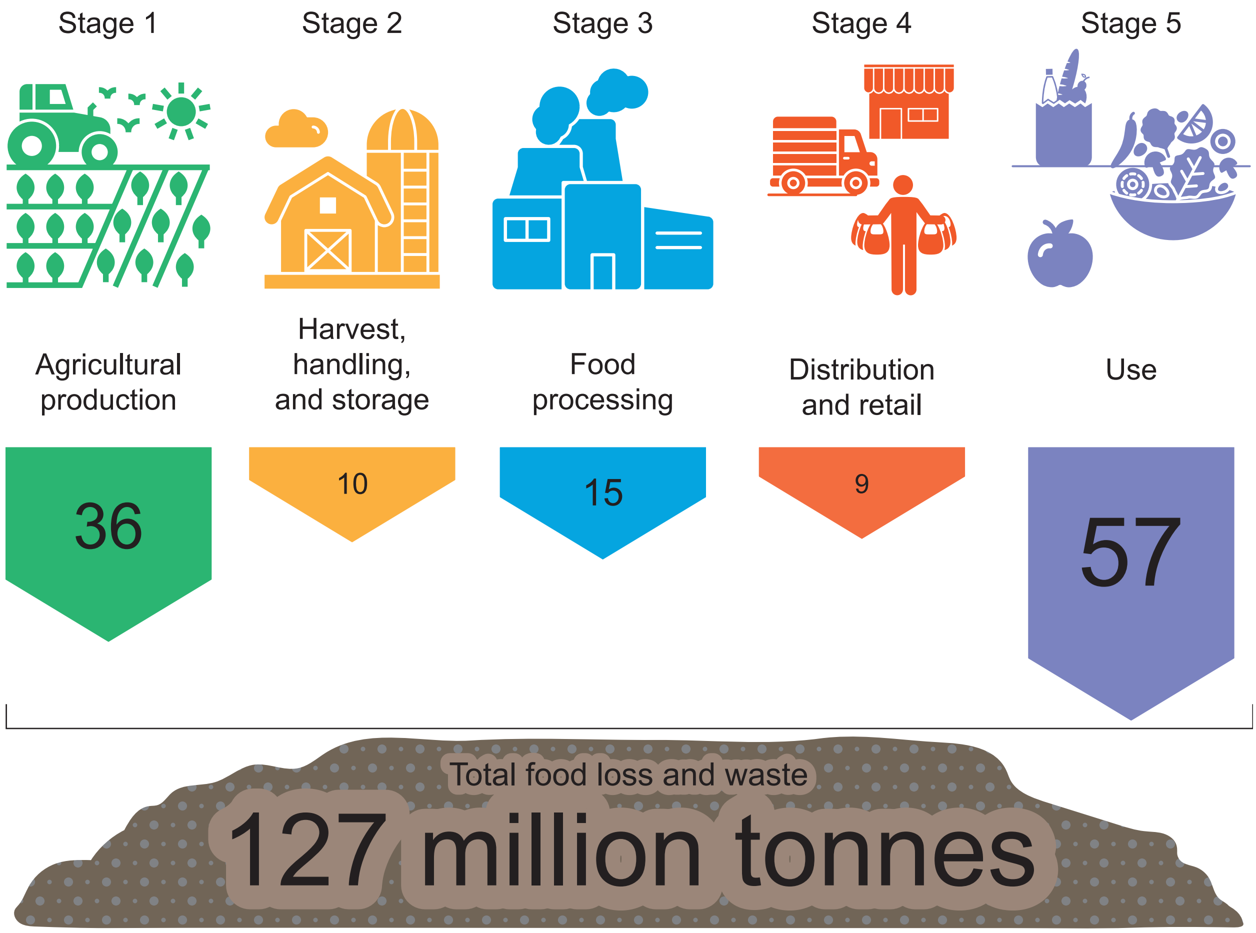
Figure 3: Food loss and waste (in million tonnes per year) in a North American food production system



3. (a) With reference to **Figure 3**, identify the stage that represents the greatest food loss and waste in North America. [1]

(b) Outline **two** strategies to reduce food waste at the 'distribution and retail' stage in North America. [2]

(This question continues on the following page)

(Question 3 continued)

(c) With reference to a stage in **Figure 3**, describe **one** reason for a difference between food loss and waste in a less economically developed country (LEDC). [2]

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(d) Discuss the sustainability of **two** solid domestic waste disposal strategies that can be used to manage food waste. [4]

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Section B

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

4. (a) Outline the difficulties in determining the carrying capacity of the human population. [4]

(b) Evaluate the potential value of aquaculture for providing food for future generations. [7]

(c) Human population dynamics are influenced more by social, cultural, political and economic factors than by resource availability.

Discuss the validity of this statement. [9]

5. (a) Outline the differences between anthropocentric and technocentric value systems. [4]

(b) Evaluate the use of ecological footprint in assessing the sustainability of a society. [7]

(c) Urbanization has had a greater effect on the quality and availability of freshwater resources than agricultural activities.

Discuss the validity of this statement. [9]

6. (a) Outline how the abundance of a motile species in an ecosystem can be measured. [4]

(b) Explain **one** natural and **one** human-caused factor that influences changes in biodiversity. [7]

(c) Discuss the effectiveness of habitat-based conservation in relation to the impacts of climate change. [9]

7. (a) Outline **two** transfers and **two** transformations within a soil system. [4]

(b) Compare and contrast the pathways of energy through the atmosphere and the pathways of energy through an ecosystem. [7]

(c) To what extent are food production systems impacted by anthropogenic (human-caused) changes to the atmosphere? [9]

References:

Figure 1 Toller, R., 2019. Harbour seal. [online] Available at: https://www.flickr.com/photos/richardtoller/48317311956/ [Accessed 8 February 2022]. Under CC BY-ND 2.0 DEED licence https://creativecommons.org/licenses/by-nd/2.0/. Image cropped.

Historic NMFS Collection, n.d. [Atlantic cod]. [online] Available at: https://commons.wikimedia.org/wiki/File:Atlantic_cod.jpg [Accessed 8 February 2022].

NOAA Fish Watch, 2012. [Atlantic herring]. [online] Available at: https://commons.wikimedia.org/wiki/File:Clupea_harengus.png [Accessed 8 February 2022].

NASA Earth Observatory, 2010. What are Phytoplankton? [online] Available at: https://earthobservatory.nasa.gov/features/Phytoplankton [Accessed 8 February 2022]. Source adapted.

Figure 2 Miyazaki, K. et al., 2021. Global tropospheric ozone responses to reduced NOx emissions linked to the COVID-19 worldwide lockdowns. *Science Advances* 7(24). [online] Available at: https://www.science.org/doi/10.1126/sciadv.abf7460 [Accessed 8 February 2022]. Distributed under a Creative Commons Attribution License 4.0 (CC BY) https://creativecommons.org/licenses/by/4.0/. Graphs simplified and redrawn.