Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MARINE SCIENCE **9693/33**

Paper 3 A Level Theory **May/June 2025**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

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[Turn over

Section A

Answer **all** questions in this section.

1 Snow crabs, *Chionoecetes opilio*, are found in the Bering Sea around Alaska, in the far northwest of North America.

Fig. 1.1 shows a snow crab.

Fig. 1.1

(a) Snow crabs are crustaceans.

State **two** features of crustaceans which are visible in Fig. 1.1.

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2 .....
[1]

(b) A female snow crab can produce up to 160 000 eggs per year. The eggs hatch in spring and the pelagic larvae feed on phytoplankton. After three to five months, in late autumn and winter, the larvae settle on the muddy sea bed. Juvenile snow crabs mature in cold water pools on the sea floor. They can take up to nine years to mature into adults.

State why the life cycle is an example of a complex life cycle.

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(c) (i) Bottom trawl surveys take place annually to monitor snow crab populations.

Suggest **two** reasons why bottom trawl surveys are a suitable method of monitoring.

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[2]

(ii) In 2018 the snow crab population was estimated at 11.7 billion. By 2022 the population was estimated at 1.9 billion.

Calculate the percentage decrease in population between 2018 and 2022.

Show your working.

..... % [2]

(iii) Only large male snow crabs are caught commercially as they are up to five times the size of females. In 2022 the commercial fishing season for snow crab was cancelled.

Use **1(c)(ii)** to explain why the commercial fishing season was cancelled.

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(iv) In 2018 and again in 2019 there was a heatwave in Alaska. Sea water temperatures increased from 1.5 °C to 3.5 °C.

Use all the information provided in the question **and** your own knowledge to suggest how the increase in sea water temperature could have caused the decrease in the snow crab population.

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(d) Scientists are concerned that in the future the sea water around Alaska will continue to warm due to climate change. Colder waters have protected the ecosystem from predatory fish such as cod, which are less adapted to very cold water. Cod is an important commercial fish.

Discuss the possible implications of increasing sea water temperatures on commercial fishing in the waters around Alaska in the future.

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[Total: 17]

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2 Sea cucumbers are benthic animals which are found in all oceans worldwide.

Fig. 2.1 shows a sea cucumber.

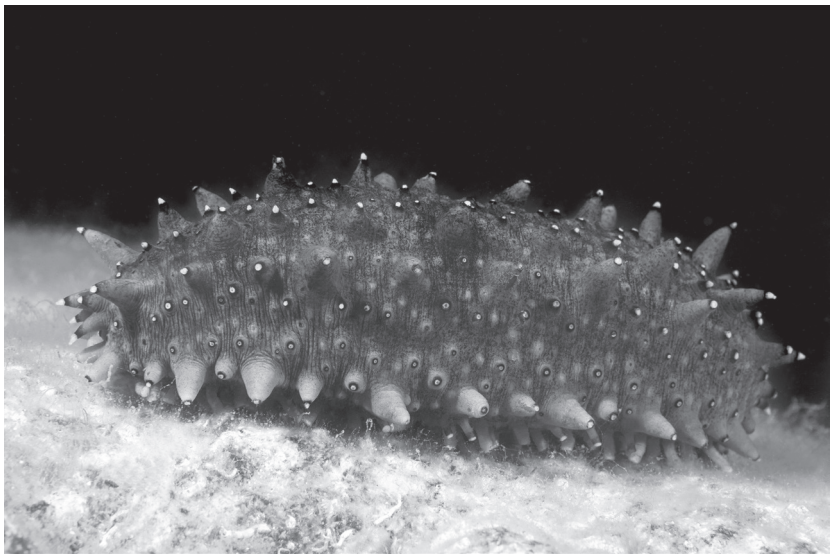

Fig. 2.1

Sea cucumbers are in high demand as a food in some Asian countries. Some people also consider them to have health benefits. Fishers in tropical countries harvest adult sea cucumbers from coastal waters for this multi-billion-dollar industry worldwide. This has resulted in overfishing, with some governments placing a ban on collection of adult sea cucumbers.

(a) Suggest **two** reasons why the ban might **not** result in an increase in the sea cucumber population.

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..... [2]

(b) Sea cucumber aquaculture started in the 1980s after successful hatchery technology was developed.

Suggest what information was required about sea cucumbers so that they could be grown successfully in a hatchery.

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(c) Small villages in Indonesia, where local fish stocks have been depleted, are being encouraged to farm sea cucumbers.

Suggest the advantages of involving the local community in managing the aquaculture project rather than having a large multinational company manage it.

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(d) Sea cucumbers eat sand, digesting the organic matter it contains, cleaning it in the process. Scientists have proposed that sea cucumbers might have a valuable role if grown under commercial fish cages in coastal waters.

Explain the benefits of growing sea cucumbers under fish cages.

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[Total: 10]

3 **(a)** Phytoplankton play an important role in extensive ponds used for aquaculture, such as providing oxygen.

State **another** reason why phytoplankton blooms are important in extensive ponds used for aquaculture but are less important in intensive ponds.

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(b) Fig. 3.1 shows the daily pattern of dissolved oxygen concentration in ponds with high and low phytoplankton abundance.

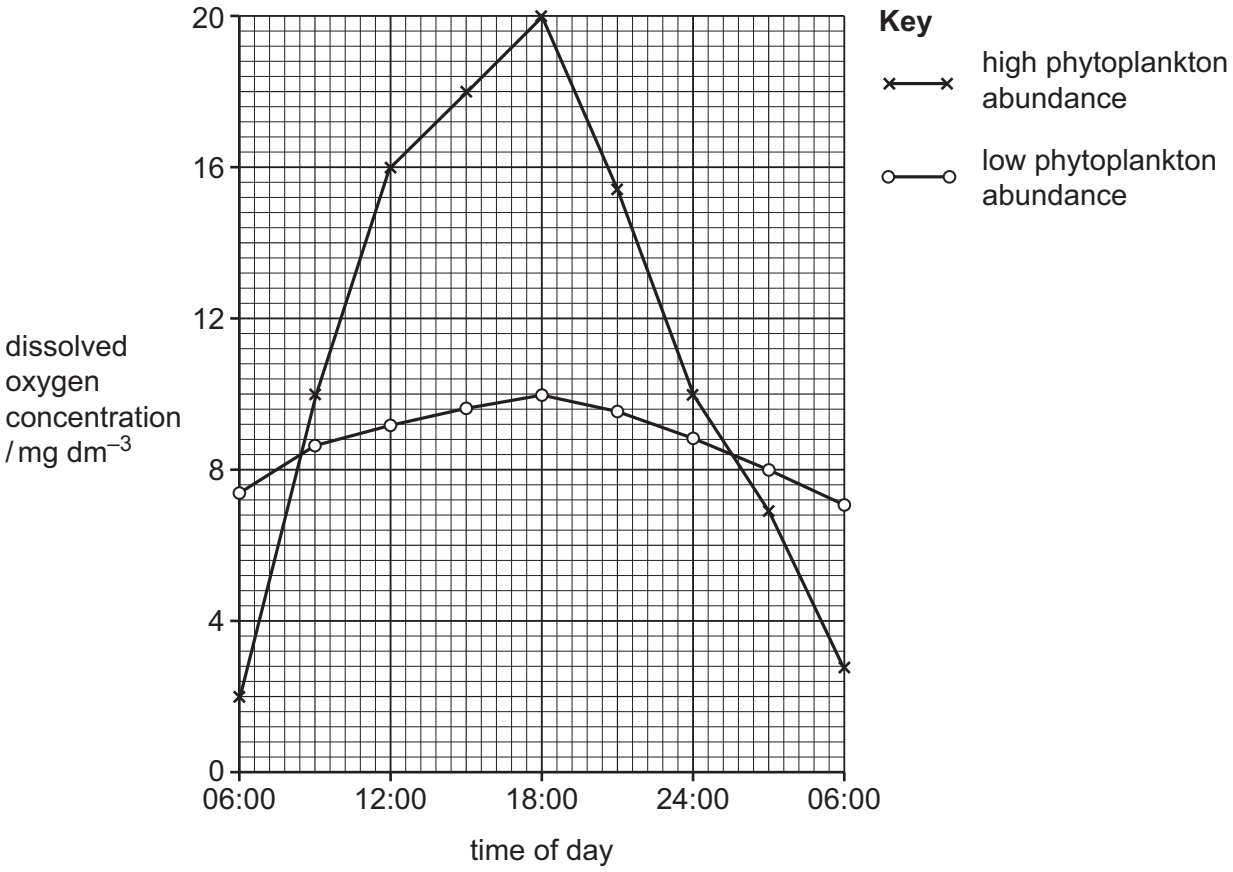

Fig. 3.1

(i) Use Fig. 3.1 to describe how an increased phytoplankton abundance affects dissolved oxygen concentrations in ponds.

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(ii) Use Fig. 3.1 **and** your own knowledge to explain why the dissolved oxygen concentration varies during the day.

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(c) Suggest **and** explain how increasing winds **and** increasing temperature would affect the shape of the graph for low phytoplankton abundance.

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[Total: 12]

4 **(a)** State the difference between the meanings of stenohaline and euryhaline.

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(b) Fig. 4.1 shows an Atlantic salmon.

Each arrow represents a process which occurs when the salmon osmoregulates in sea water. The arrows show the direction of movement.

Arrow **C** represents the removal of excess sodium and chloride ions from the gills.

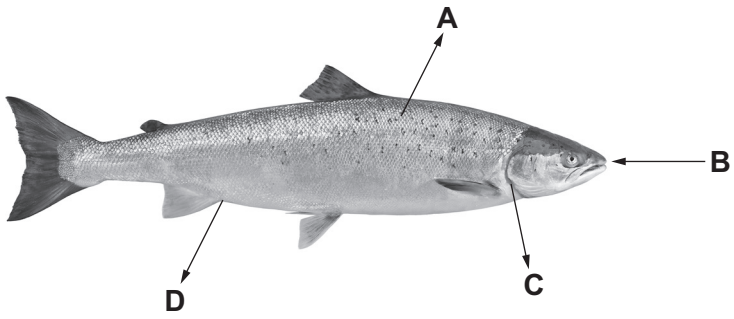

Fig. 4.1

Describe the processes represented by arrows **A**, **B** and **D**.

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B .....

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D .....

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[3]

(c) Process **C** uses active transport. Explain why active transport is necessary.

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[Total: 6]

Section B

Answer **all** questions in this section.

5 Describe the conditions at hydrothermal vents **and** the ecosystems that hydrothermal vents support.

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6 **(a)** Green crabs, *Carcinus maenas*, are an invasive species found in coastal habitats including estuaries and marshes. They actively feed on oysters, mussels, clams, worms and small crustaceans. A female crab can hold up to 185 000 eggs at one time.

Fig. 6.1 shows a green crab on a sandy shore. Fig. 6.2 shows the distribution of green crabs worldwide.

Fig. 6.1

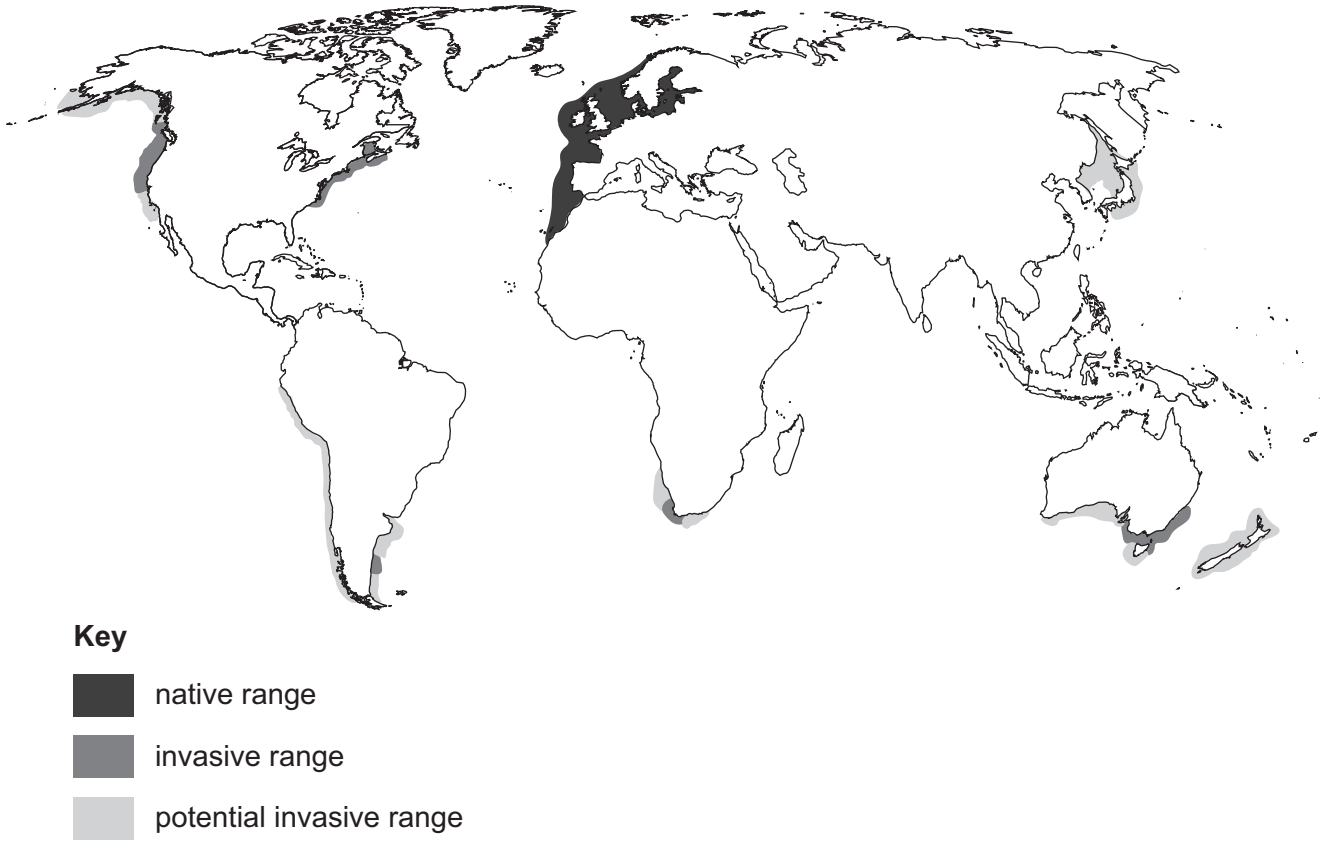

Fig. 6.2

State reasons why green crabs pose a threat to native marine species and ecosystems.

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(b) Discuss how discarded plastic poses a threat to marine species and ecosystems.

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[Total: 14]

7 Describe the structure **and** function of a mitochondrion.

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