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MARINE SCIENCE**9693/31**

Paper 3 A Level Theory

May/June 2026**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. Do **not** use correction fluid or tape.
- 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.

Section A

Answer **all** questions in this section.

- 1 Chesapeake Bay is one of the most productive estuaries in the world, with over 3600 species of animals and plants. The bay provides a range of vitally important habitats for wildlife including marshland, mudflats, shallow water and open water. Chesapeake Bay is also an important area for recreation, especially for boating activities.

Figure 1.1 shows the Chesapeake Bay estuary.

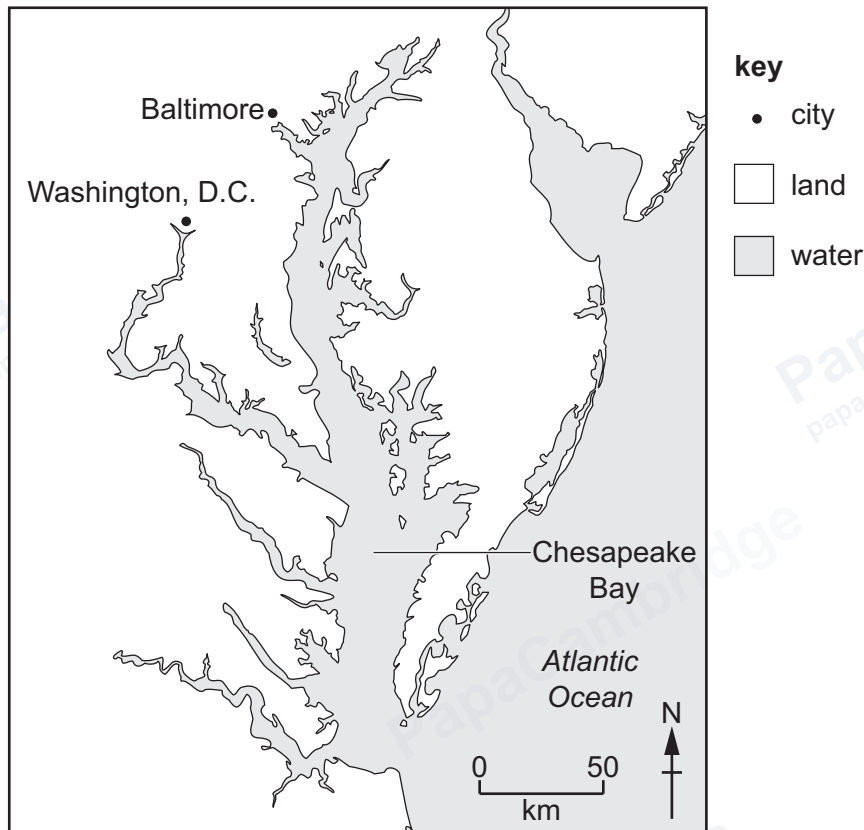


Figure 1.1

- (a) (i) Seagrass beds are found in tidal areas of streams and rivers which flow into the bay. The water here is shallow and the substrate is muddy.

Explain how shallow water and a muddy substrate benefit seagrass.

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..... [2]



- (ii) Seagrass beds improve water quality within the bay.

Explain how seagrass beds improve water quality within the bay.

.....

.....

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.....

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..... [3]

- (b) Figure 1.2 illustrates the abundance of seagrass in the bay from 2000 to 2021. Abundance was measured as the number of hectares of seabed covered by seagrass.

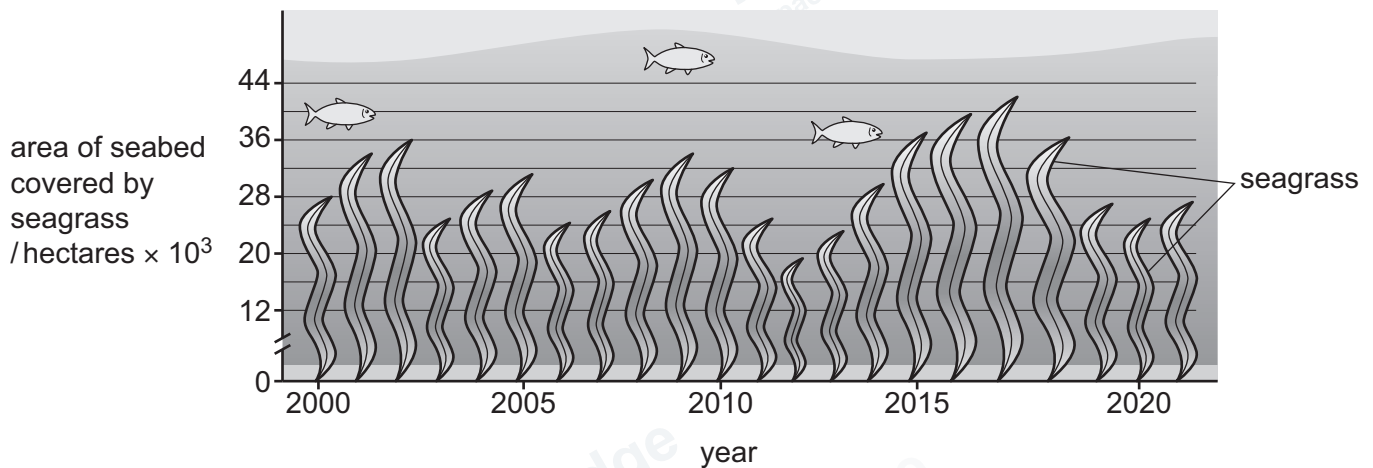


Figure 1.2

- (i) Use Figure 1.2 to describe seagrass abundance from 2000 to 2021.

.....

..... [1]

- (ii) Use Figure 1.2 to estimate the maximum range in seagrass abundance between 2000 and 2021.

..... hectares $\times 10^3$ [2]

(c) Seagrass beds have decreased over the last century by 37%. Two probable causes are:

- increased deforestation and land clearance for urban development
- increased rainfall.

Explain how these two factors could cause a decrease in seagrass beds.

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..... [4]

(d) Use **all** the information provided **and** your own knowledge to suggest possible methods which can be used to restore seagrass beds in Chesapeake Bay.

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..... [2]

[Total: 14]



2 (a) Complete the passage on aerobic respiration.

Aerobic respiration can only occur when the gas is available.

Aerobic respiration is the process that organisms use to
energy from

This energy is transferred to molecules of

The waste products of aerobic respiration are and
.....

[4]

(b) State the **exact** sites of aerobic respiration **and** anaerobic respiration in a cell.

aerobic respiration
.....

anaerobic respiration
.....

[2]

[Total: 6]

- 3 A student carried out a belt transect to sample the distribution of macroalgae on a rocky shore. They sampled six species of macroalgae: two brown (B1 and B2), two green (G1 and G2) and two red (R1 and R2).

The species were sampled every metre from low water mark (LWM) to high water mark (HWM).

Figure 3.1 shows the results of the sampling in the form of a kite diagram. The width of the shaded area represents the abundance of the species at each height.

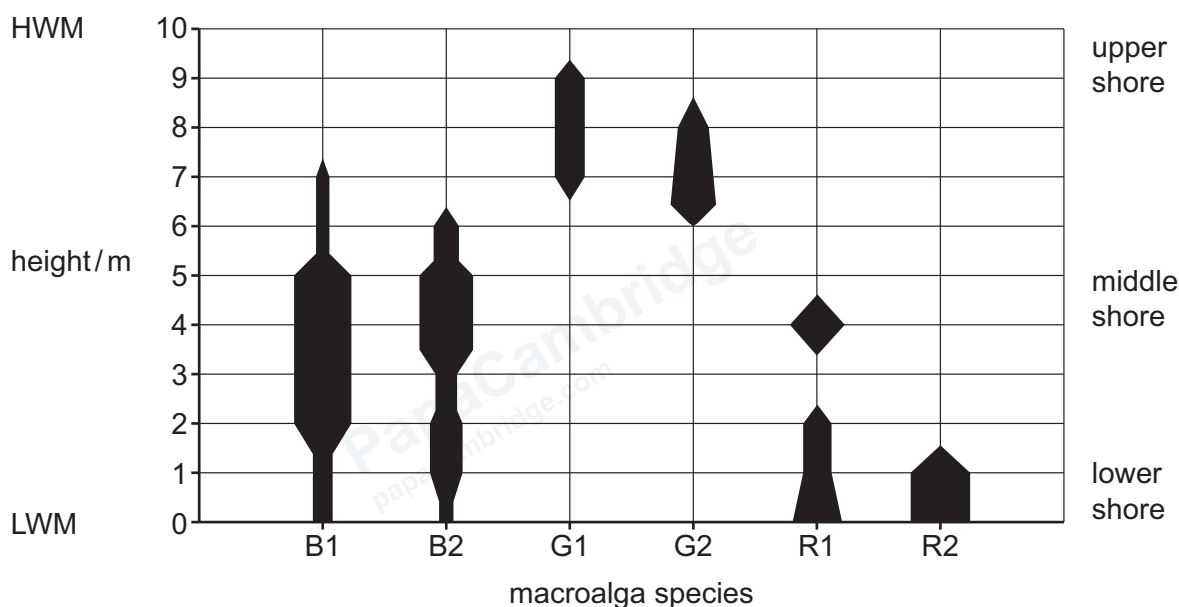


Figure 3.1

- (a) State the apparatus the student could use to sample the abundance of the macroalgae.

..... [1]

- (b) Explain why the method that the student used can be described as systematic sampling.

..... [1]

- (c) The student counted the number of each species at each height to compare abundance. This method is time-consuming.

Suggest a faster method the student could have used to compare the abundance of each species at each height.

..... [1]

(d) Give reasons why green macroalgae are only found on the upper shore.

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..... [3]

(e) Use Figure 3.1 **and** your own knowledge to explain how pigments are important in determining the distribution of red **and** brown macroalgae on a rocky shore.

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..... [4]

(f) The result for species **R1** at 4 m is an anomaly.

Suggest an explanation for the presence of species **R1** at 4 m.

.....

..... [1]

[Total: 11]

- 4 (a) The natural greenhouse effect maintains the Earth's temperature within the range required for life. Greenhouse gases in the atmosphere help to maintain this temperature range.

(i) Name **two** greenhouse gases found in the atmosphere.

1

2 [1]

(ii) Describe how greenhouse gases help to maintain the Earth's temperature.

.....
.....
.....
..... [2]

(iii) Human activities are causing an increase in greenhouse gases in the atmosphere.

State **two** human activities which cause an increase in greenhouse gases.

1

2 [2]

(b) Global air temperatures naturally increase and decrease throughout the year.

Figure 4.1 shows the range in mean global air temperatures from 1940 to 2022. Individual data are shown for 2023.

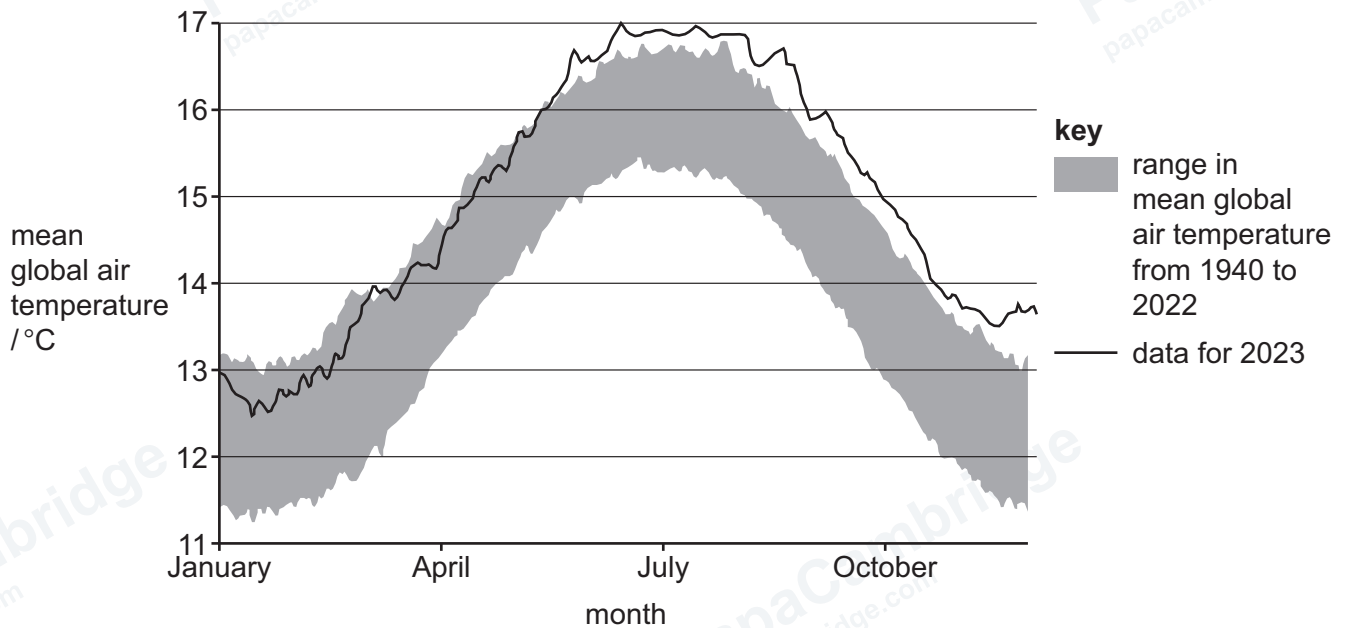


Figure 4.1

Use Figure 4.1 to suggest how the data might provide evidence for global warming.

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..... [2]

- (c) Figure 4.2 shows mean global sea surface temperatures from 1982 to 2021. Individual data are shown for 2022 and 2023.

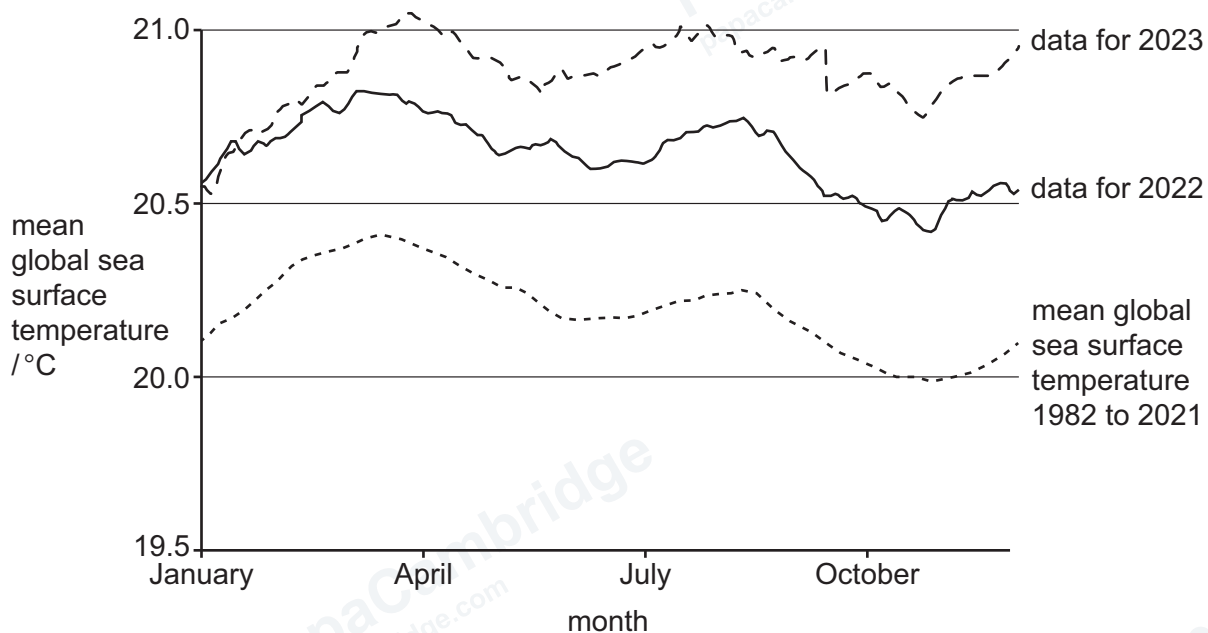


Figure 4.2

- (i) Use Figure 4.2 to suggest how increasing sea surface temperatures could affect respiration **and** reproduction in marine fish.

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..... [3]



- (ii) A global temperature increase of 1.5 °C could have catastrophic effects on our climate. In 2023 an El Niño event began.

Explain how an El Niño event might affect global climate.

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..... [4]

[Total: 14]



Section B

Answer **all** questions in this section.

- 5 Integrated multitrophic aquaculture, IMTA, is a method of aquaculture in which two or more species are grown together. IMTA can be used both in the ocean and in land-based facilities. There has been a significant increase recently of salmon farmers growing seaweeds such as kelp next to sea cages.

Suggest **and** explain the advantages that IMTA offers over growing salmon and kelp separately.

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[10]



- 6 (a) Figure 6.1 shows Visking tubing containing a 0.5 mol dm^{-3} sucrose solution. The beaker contains a 0.2 mol dm^{-3} sucrose solution.

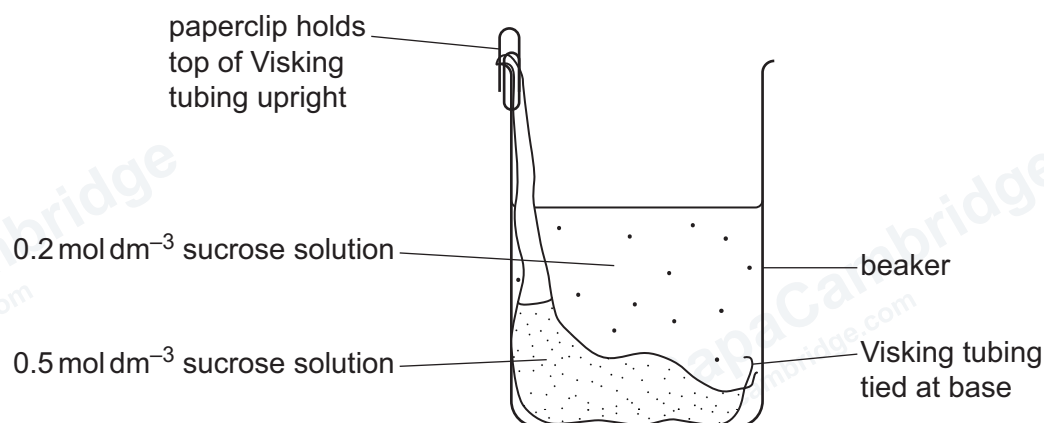


Figure 6.1

Describe **and** explain what will happen in this apparatus if it is left for one hour at room temperature. Use the term water potential in your answer.

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..... [5]



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[9]

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