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National Qualifications 2025

Mark

X826/76/01

Environmental Science Paper 1

WEDNESDAY, 28 MAY

9:00 AM – 9:45 AM

X8267601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 20

Attempt ALL questions.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

X8267601

Total marks — 20

Attempt ALL questions

Sargassum natans and *Sargassum fluitans* are two species of macro-algae. Air-filled bladders allow them to float on the ocean surface, and they do not root on the seabed. The *Sargassum* accumulates in enormous rafts due to the action of wind and waves. The rafts provide an important habitat in areas of open ocean where marine biomass is very low.

Sargassum has a very high productivity rate, doubling its biomass every 10 days under optimum conditions. However, the growth period lasts only around 6 months each year before seasonal changes limit productivity.

A company plans to take advantage of *Sargassum*'s high productivity by farming both species and capturing the carbon the algae removes from the atmosphere. This is known as carbon sequestration.

The company aims to set up a 272-km wide aquafarm in the South Atlantic Gyre. This is an area where *Sargassum* does not survive naturally, due to the surface water being extremely nutrient poor. To overcome this, the company will use pipes to extract nutrient-rich water from deeper layers of the ocean.

At the end of the highest productivity period the *Sargassum* will be harvested and baled. The bales will be sunk and stored on the seafloor in a deep area of the ocean, where low oxygen conditions will prevent them from decomposing. This could potentially allow the carbon to be sequestered permanently, and may provide an opportunity for the company to sell carbon credits on the global carbon market. Such credits allow businesses that cannot easily cut their own emissions to offset these by buying credits from other businesses.

Some benefits of using the South Atlantic Gyre are that it is not crossed by major shipping routes or used by migrating whales, and the aquafarm will take up only a small area of the gyre.

The company's plan is innovative and not yet fully tested. A small-scale pilot project is underway, with limited funding. If successful, the company will be seeking investors once any major technical and scientific uncertainties have been addressed.

MARKS | DO NOT WRITE IN THIS MARGIN

1. (a) Suggest why *Sargassum* rafts offer a valuable habitat for marine species. **1**

(b) Almost all photosynthesis in oceans is performed by free-floating algae, with rooted algae and marine plants making only a small contribution.

(i) Suggest why rooted algae and marine plants contribute so little to photosynthesis in oceans. **1**

(ii) Algal chlorophyll can be detected from space by satellites. The data can be used to estimate ocean productivity.

State what is meant by *net primary productivity*. **1**

(iii) **Source B** includes estimated mean annual global carbon sequestration data for some marine primary producers.

1 kg of sequestered carbon has the potential to release 3.67 kg of carbon dioxide.

Calculate how much carbon dioxide, in kg, is sequestered by *Sargassum* each year. **2**

Space for working

[Turn over

2. By placing the aquafarm in the middle of the South Atlantic Gyre, the company believes physical methods of containing the *Sargassum* will not be required.

(a) State what is meant by an *ocean gyre*. **1**

(b) Suggest why the company believes that physical containment of the *Sargassum* will not be required. **1**

(c) The South Atlantic Gyre's location means that evaporation will be high, resulting in the surface water being highly saline. The surface water is also low in nutrients.

(i) **Source E** shows the plan for the aquafarm.

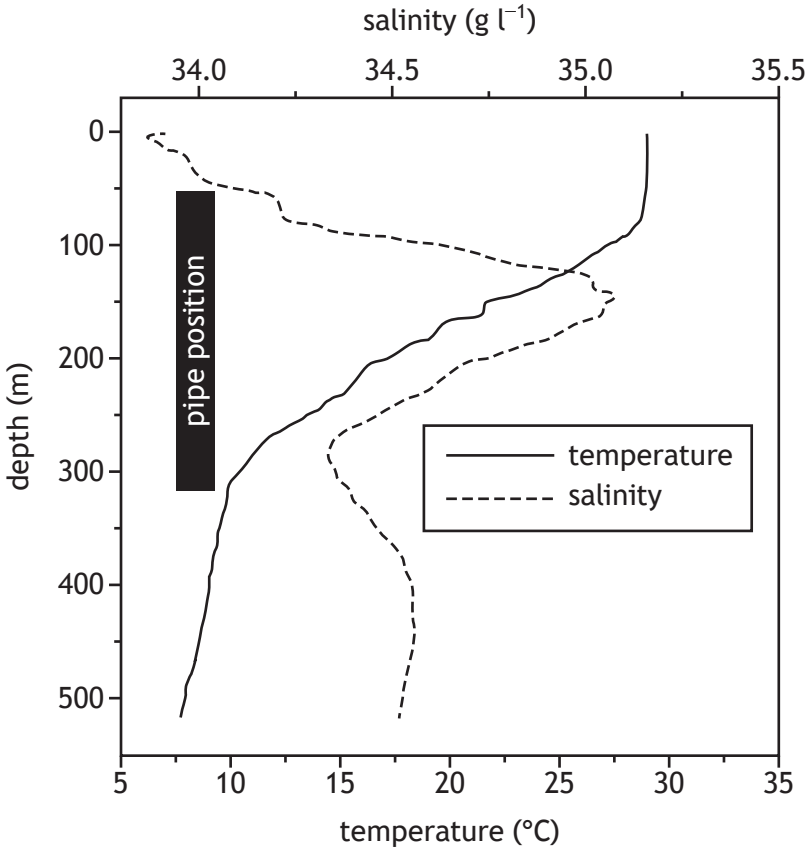
A mechanical pump will initially be used to draw up nutrient-rich water from a deeper layer of the ocean into the pipes. The pump can then be removed and the process will continue unaided.

Explain why the process will continue unaided once the pump is removed. **2**

MARKS

(ii) A small-scale experiment to assess changes in temperature and salinity with depth was carried out in a deep part of the Pacific Ocean. Pipes were suspended 55 m below the surface, and a pump used to draw water up into the pipes.

The graph shows the experimental findings.



Describe **fully** the relationship shown in the graph between **either** depth and temperature **or** depth and salinity. **2**

(iii) Suggest one reason why the results from the experimental setup in the Pacific Ocean may not be valid for the aquafarm in the South Atlantic Ocean. **1**

3. (a) The bales of harvested *Sargassum* will be stored on the seafloor.

Explain one environmental benefit of permanently storing bales of *Sargassum* on the seafloor. **1**

(b) Suggest how a named type of natural event could impact on the aquafarm project. **1**

(c) *Sargassum* escaping from naturally occurring rafts in the North Atlantic Gyre is an ongoing issue for countries with coastline along the Caribbean Sea and Gulf of Mexico (**Sources A and F**). However, *Sargassum* is increasingly being viewed as a valuable asset (**Source G**).

Sargassum can be processed for energy generation.

One approach is to use gasification or pyrolysis to produce biogas.

Explain one benefit of producing biogas from *Sargassum*. **1**

4. At the end of the pilot project, the company must decide whether the farming of *Sargassum* in an ocean gyre is likely to be commercially viable. Major investment will be required to set up the full-size aquafarm.

Using the evidence from the sources and your knowledge of environmental science, decide whether the benefits of the project would outweigh any challenges and be worth investing in.

Justify your decision. **5**

Invest in the project ☐

Do not invest in the project ☐

[END OF QUESTION PAPER]

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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