CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

MARINE SCIENCE 9693/02

Paper 2 AS Data-Handling and Free-Response **October/November 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **both** questions in this section.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **both** questions in this section.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

[Turn over

Section A

Answer **both** questions in this section.

1 A student investigated the substrate (surface) that barnacle larvae preferred to settle on.

They chose four substrates:

- smooth granite
- rough sandstone
- loose sand
- smooth plastic (from the hull of a boat).

(a) State **one** hypothesis the student could test in this investigation.

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.... [1]

The student selected two pieces of each substrate, of different sizes, and placed them in four separate tanks, as shown in Fig. 1.1.

Sea water was added to the tanks, and barnacle larvae of the same age, of the species *Balanus glandula*, were placed in the water in each tank. Phytoplankton were added to the water each day to provide food for the barnacle larvae.

| smooth
granite | rough
sandstone | loose sand
(in a tray) | smooth
plastic |
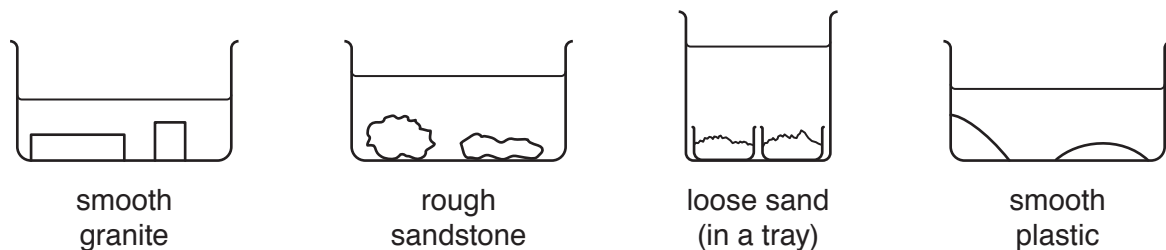
Fig. 1.1

The student removed the pieces of substrate each day and counted the number of larvae that had settled on each piece. The substrates were then returned to the tanks, in the same position each time.

Table 1.1 shows the results after 10 days.

Table 1.1

substrate	number of larvae settled
smooth granite	1
rough sandstone	2
loose sand	0
smooth plastic	1

(b) State **one** variable that the student controlled in this investigation.

.... [1]

(c) The student could not reach a firm conclusion from the data they had collected.

Suggest **three** reasons why a firm conclusion could not be reached.

1 ....

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2 ....

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3 ....

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[3]

(d) Suggest how the experimental method could have been improved.

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.... [4]

[Total: 9]

2 *Tetraselmis* is a single-celled phytoplankton, often cultured as a food source for the aquaculture of marine fish larvae.

Tetraselmis is grown using a batch culture method. All the required nutrients and a small population of *Tetraselmis* are placed into a container and grown for several days. Carbon dioxide is continuously bubbled through the water and the light intensity is kept constant.

Table 2.1 shows the mean cell density of *Tetraselmis* grown using a batch culture method over 10 days.

Table 2.1

day	mean cell density /cells per mm^3
0	0
1	70
2	120
3	300
4	
5	1400
6	1750
7	1900
8	2000
9	1800
10	1500

To obtain the data in Table 2.1, five samples of the culture were counted daily and a mean value was calculated.

Table 2.2 shows the data for day 4.

Table 2.2

sample number	1	2	3	4	5
cell density / cells per mm^3	681	201	726	654	738

(a) (i) Calculate the mean cell density for day 4, using sample numbers 1, 3, 4 and 5.

Give your answer to an appropriate number of significant figures.

.... cells per mm^3 [1]

(ii) Suggest why sample 2 was not used to calculate the mean cell density.

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.... [1]

(b) Plot a line graph to display the data in Table 2.1. Include your calculated value for day 4.

Draw a smooth curve of best fit.
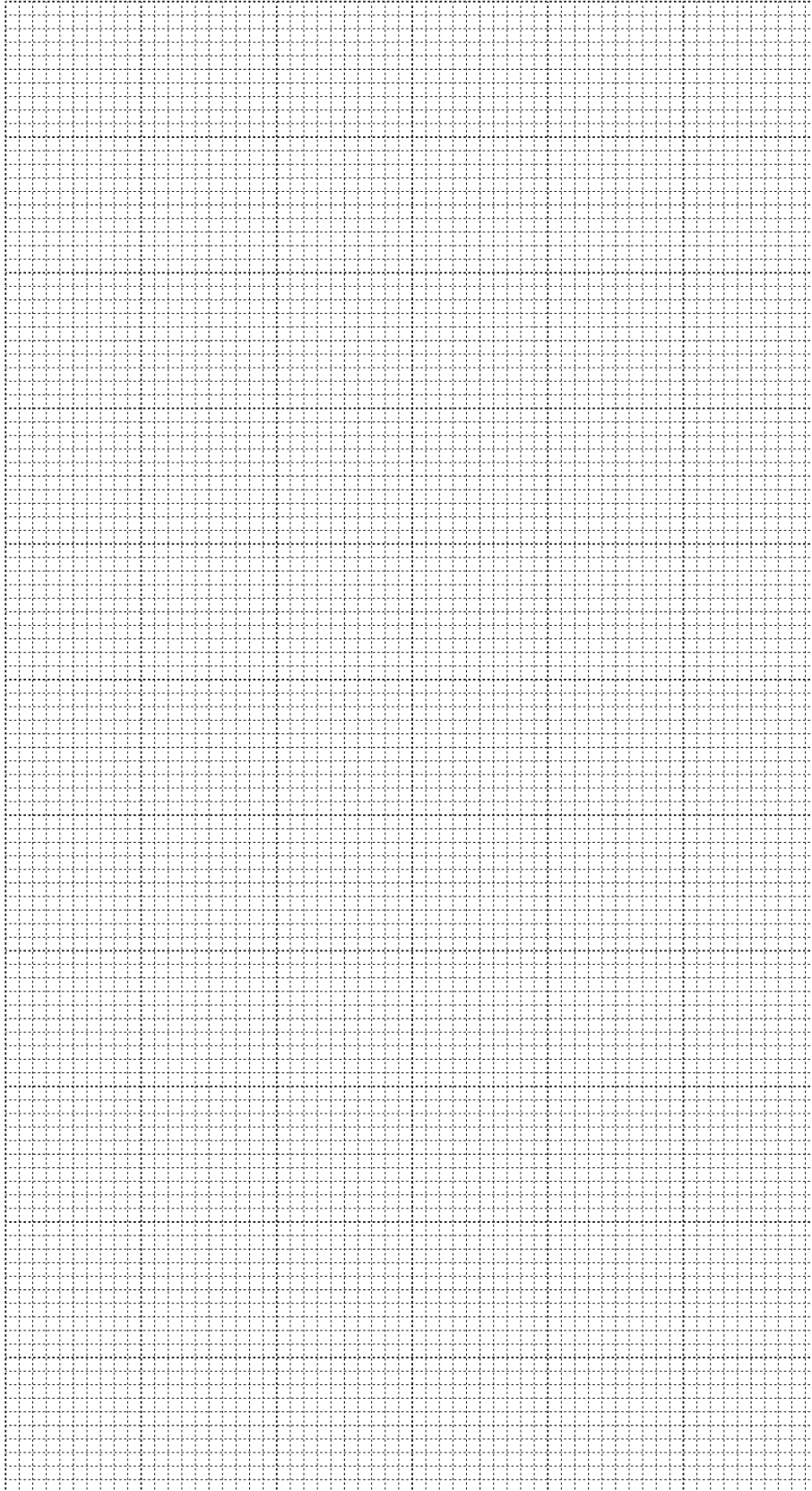
[4]

(c) (i) Use the results in Table 2.1 and your graph to suggest the day on which it would be best to harvest *Tetraselmis*.

Give a reason for your answer.

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.... [2]

(ii) Predict what would happen to the mean cell density, if the culture was continued to day 15.

Explain your prediction.

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.... [2]

(d) Name the process which phytoplankton use to transfer light energy to a form available to the rest of the food chain.

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.... [1]

[Total: 11]

Section B

Answer **both** questions in this section.

3 **(a) (i)** Outline the environmental factors of shorelines that are required for the development of mangrove forests.

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.... [4]

(ii) Explain how the tidal cycle would affect the salinity in a mangrove forest in an estuary over the period of a single day.

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.... [4]

(iii) Suggest **two** impacts of removing mangrove forests from a shoreline.

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2 ....

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[2]

(b) Coral reefs are rarely found near river estuaries or deltas.

Explain the reasons for this.

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.... [5]

[Total: 15]

4 (a) (i) Describe how hydrothermal vents are formed.

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.... [4]

(ii) Succession occurs at newly formed hydrothermal vents.

Explain the meaning of the term *succession* **and** describe the succession at hydrothermal vents.

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.... [6]

(b) Ocean acidification is a threat to many marine ecosystems.

Explain the causes and effects of ocean acidification.

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.... [5]

[Total: 15]

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