Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0704770389

MARINE SCIENCE **9693/21**

Paper 2 AS Level Data-handling and Investigative Skills **October/November 2022**

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.

DC (PQ/FC) 303027/4

Answer **all** questions.

1 A student was given water samples from three different environments to compare.

They tested the pH of the samples.

(a) State **two** ways of measuring pH.

1 ....

2 ....
[2]

(b) The student measured the pH using two different methods.

Table 1.1 shows the results.

Table 1.1

water sample	**pH**	
	method 1	**method 2**
J	8.2	8.0
K	3.6	4.0
L	7.6	7.0

(i) Suggest why the student did **not** calculate the mean of the two methods for each sample.

....

.... [1]

Dissolved nutrients affect the pH of water.

(ii) Identify which sample, **J**, **K**, or **L**, came from near a hydrothermal vent.

.... [1]

(iii) Explain your answer from **(ii)** for the sample from the hydrothermal vent.

....

....

....

.... [2]

(c) Explain why the dissolved **oxygen** level in surface open ocean water is higher than in water near a hydrothermal vent.

....

....

....

....

....

.... [4]

[Total: 10]

2 Fig. 2.1 shows a high magnification image of a diatom.

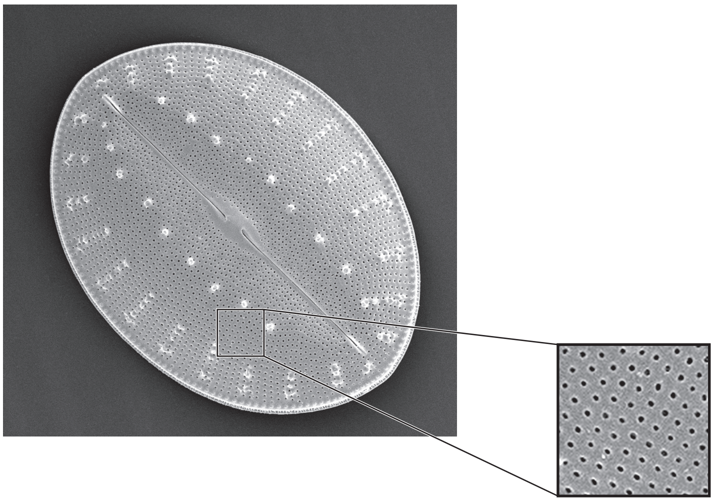

Fig. 2.1

(a) Make a large drawing of the diatom shown in Fig. 2.1.

Include features, but do **not** include the pores.

Do **not** label the drawing.

[4]

(b) Diatoms are a possible source of biofuel. Diatoms absorb carbon dioxide from the atmosphere for photosynthesis.

With suitable growing conditions and nutrient availability diatoms produce large amounts of lipids. Lipids can form up to 75–80% of their mass. The biomass of a population of diatoms can double in a few hours. Lipids can be removed and turned into biofuel to be used in place of fossil fuels such as oil, coal and natural gas.

Diatoms require silicates as an essential nutrient to make parts of their cells. Some land plants also use silicates to make their cells. Other land plants use cellulose to make their cells. Land plants that need silicates only use 8% of the energy to make their cells compared to plants that use cellulose. Scientists believe diatoms may have similar energy requirements to land plants that use silicates.

(i) State the **word** equation for photosynthesis.

....

.... [2]

(ii) Describe the chemical structure of lipids.

....

....

....

.... [2]

(iii) Suggest **two** ways that silicates are replenished into surface waters.

1 ....

....

2 ....

....
[2]

(iv) Evaluate the statement:

Scientists believe diatoms may have similar energy requirements to land plants that use silicates.

....

....

....

.... [2]

(v) State **two** services that diatoms provide to the environment.

1 ....

2 ....
[2]

(c) Fig. 2.2 shows a food web containing diatoms.

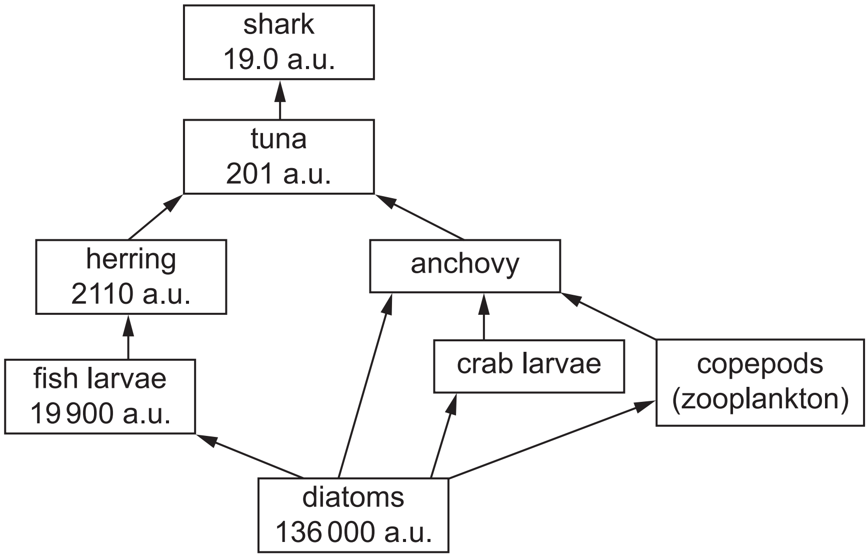

Fig. 2.2

(i) State the name of a tertiary consumer found in Fig. 2.2.

.... [1]

(ii) The energy held in each trophic level for **one** food chain is shown in arbitrary units (a.u.) in the food web.

Construct a pyramid of energy for this food chain. Label the pyramid of energy.

[3]

(iii) The energy transfer efficiency is the percentage of energy held in one trophic level that is passed onto the next.

Calculate the energy transfer efficiency from diatoms to fish larvae.

Give your answer to an appropriate number of significant figures.

Show your working.

.... %
[3]

(iv) The energy transfer efficiency from tuna to shark is 9.45%.

Explain reasons why the energy transfer efficiency calculated in **(c)(iii)** differs from the energy transfer efficiency from tuna to shark.

....

....

....

....

....

.... [3]

(v) Suggest the impact on the pyramid of energy from **(c)(ii)** if the quantity of silicates in the ocean is reduced.

....

.... [1]

[Total: 25]

3 Many organisms have a planktonic stage in their development.

(a) Define the term plankton.

....

.... [2]

(b) Some zooplankton show a vertical swimming response towards light when a light stimulus is applied above them. These zooplankton do **not** swim in darkness.

An investigation is carried out in a laboratory to compare the swimming speeds of zooplankton of different sizes in response to white light.

A student makes the hypothesis:

The swimming speed of zooplankton is proportional to their size.

The maximum speed of any of the zooplankton provided is 10 mm s^{-1}. The size range of the zooplankton is 2–10 mm.

Speed can be calculated using the equation: speed = $\frac{\text{distance}}{\text{time}}$

(i) List the equipment required for this investigation.

1 ....

2 ....

3 ....
[3]

(ii) State **three** key variables to standardise in this investigation.

1 ....

2 ....

3 ....
[3]

(iii) Outline a method to compare the swimming speeds of zooplankton of different sizes in response to white light.

....

....

....

....

....

....

....

....

....

....

....

....

.... [5]

(c) Use the space below to draw a suitable table to record the results from the method described in **(b)(iii)**.

Include full headings and units in the table.

Do **not** write in any results.

[2]

[Total: 15]

4 Skate are cartilaginous fish which live in the benthic zone.

(a) **(i)** State **two** ways that cartilaginous fish differ from bony fish.

1 ....

2 ....
[2]

(ii) State the location of the benthic zone.

.... [1]

(b) Fig. 4.1 shows some anatomy of a skate fish.

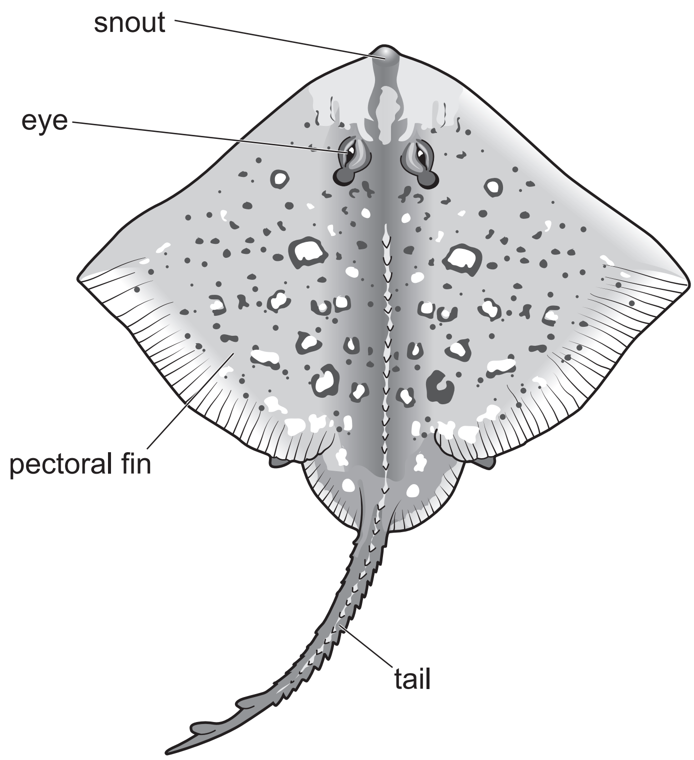

Fig. 4.1

Fig. 4.2 shows five species of skate, **A**, **B**, **C**, **D** and **E**.

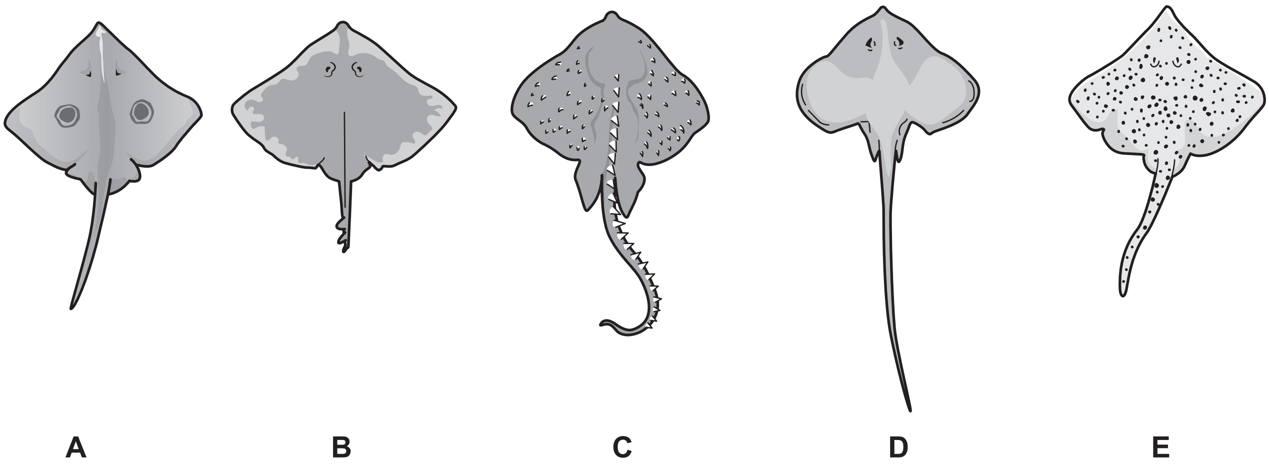

Fig. 4.2

Use the key to identify the binomial name of species **C**.

1	Sharp snout	go to 2
	Rounded snout	go to 3
2	One large spot on each pectoral fin	*Beringraja binoculata*
	Even-sized small spots all over the body	*Dipturus laevis*
3	A row of thorns from the head down the body	*Amblyraja radiata*
	No thorns on the body	go to 4
4	Tail longer than the body	*Fenestraja ishiyamai*
	Tail shorter than the body	*Dipturus chinensis*

Binomial name of species **C** is .... [1]

(c) Suggest **two** adaptations skate have to living in the benthic zone.

1 ....

....

2 ....

....

[2]

[Total: 6]

5 Table 5.1 shows the salinity at different depths in an estuary.

Table 5.1

depth / m	**salinity / parts per thousand (ppt)**
0	2
2	3
4	4
6	26
8	28
10	29
12	30

(a) **(i)** Plot a suitable graph to show the data in Table 5.1.

[4]

(ii) Describe the pattern shown by the graph in **(a)(i)**.

....

....

....

.... [2]

(iii) State the name given to the region between 4 m and 6 m depth.

.... [1]

(iv) Use your graph in **(a)(i)** to estimate the salinity at a depth of 5.2 m.

.... ppt [1]

(v) Suggest why this value may **not** be accurate.

....

.... [1]

(b) An estuary with the salinity gradient shown in Table 5.1 only forms where there is a low tidal range, such as in the Mediterranean Sea.

Suggest **one** reason for this.

....

.... [1]

[Total: 10]

6 A report was made to scientists that an invasive tree species, *Nypa fruticans*, had become established within an area of mangrove forest on the west coast of Africa.

An invasive species is an organism that is not native to an area and that easily spreads to cause ecological damage in the new habitat.

The scientists investigated this using the hypothesis:

The presence of an invasive species reduces biodiversity.

Scientists studied two areas of mangrove of equal size. The invasive *Nypa* species was present in area **Y**, but **not** in area **X**.

Large mangrove plant species were identified and the number of each species of plant in each transect was recorded. The results are shown in Table 6.1.

(a) Calculate the total number of all species in mangrove area **X** and record it in Table. 6.1.

Table 6.1

species name	number of individuals in mangrove area X	number of individuals in mangrove area Y
Acrostichum aureum	24	3
Avicennia germinans	19	14
Drepanocarpus lanatus	24	4
Nypa fruticans	0	53
Rhizophora harrisonii	3	0
Rhizophora racemosa	50	35
Total number of all species	....	109

[1]

(b) Simpson's index of diversity is used to calculate the species diversity of each habitat. Table 6.2 shows the data calculated for mangrove area **X**.

The equation for Simpson's index of diversity is:

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

where:
D = Simpson's index of diversity
Σ = sum of (total)
n = number of individuals of each **different** species
N = the total number of individuals of **all** species

Use the formula and the data from Table 6.1 to complete Table 6.2 **and** calculate the Simpson's index of diversity for mangrove area **Y**.

Table 6.2

species name	mangrove area X n/N	mangrove area X $(n/N)^2$	mangrove area Y n/N	mangrove area Y $(n/N)^2$
Acrostichum aureum	0.20	0.0400	0.03	0.0009
Avicennia germinans	0.16	0.0256	0.13	0.0169
Drepanocarpus lanatus	0.20	0.0400	0.04	0.0016
Nypa fruticans	0	0	....	....
Rhizophora harrisonii	0.03	0.0009	....	....
Rhizophora racemosa	0.42	0.1764	....	....
Σ		0.2829		....

Simpson's index of diversity for mangrove area **X** = 1 – 0.2829 = 0.7171

Simpson's index of diversity for mangrove area **Y** = ...

[5]

(c) Discuss the extent to which the hypothesis is proven.

....

....

....

....

....

.... [3]

[Total: 9]