Surname	Centre Number	Candidate Number
Other Names		2

GCE AS – NEW

B400U20-1

S17-B400U20-1

BIOLOGY – AS component 2
Biodiversity and Physiology of Body Systems

TUESDAY, 6 JUNE 2017 – AFTERNOON

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**16**	
3.	**14**	
4.	**14**	
5.	**11**	
6.	**9**	
Total	**75**	

B400U201
01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **6**.

The quality of written communication will affect the awarding of marks.

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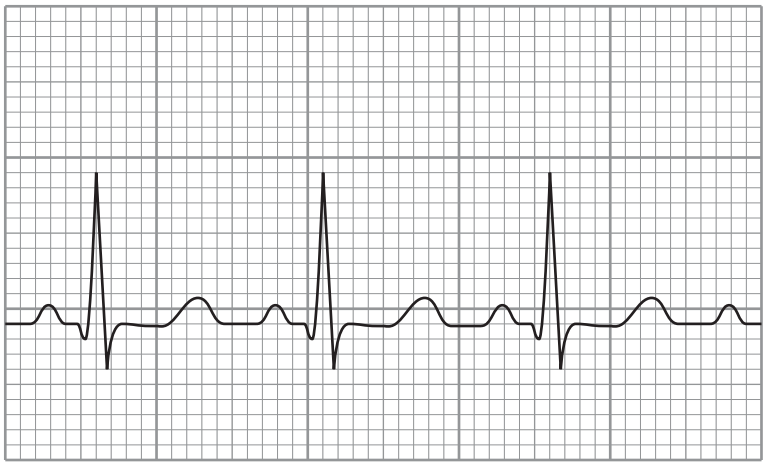
Answer **all** *questions.*

1. The diagram below shows a trace used by doctors to investigate the health of a patient's heart. Electrodes are placed on the patient's skin and detect tiny electrical changes on the skin caused by the electrical output of the heart. The output is amplified and recorded on a moving graph paper trace using a standard grid so that it is possible for doctors to analyse the output. The horizontal axis on the graph paper represents time.



(a) (i) What name is given to this type of trace? [1]

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(ii) Calculate the heart rate of this person in beats per minute given that each small square on the trace represents 0.04 seconds. Show your working. [2]

Heart rate = ... b.p.m.

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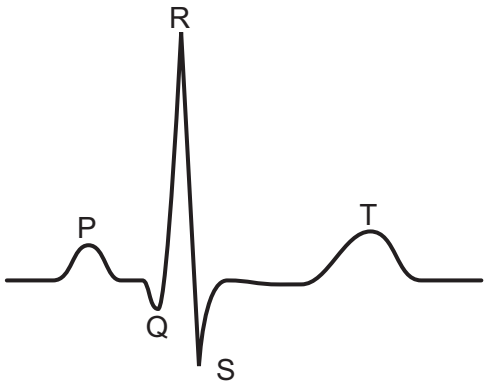
(b) The diagram below shows the trace for one cardiac cycle.



(i) In the table below, use letters from the diagram to indicate which sections of the trace correspond to the events of the cardiac cycle. [2]

Cardiac cycle events	Section of trace
Ventricular diastole	
Atrial systole	
Ventricular systole	

(ii) These events in the cardiac cycle are coordinated by specialised tissues in the heart muscle. Describe the role of the following tissues in the cycle.

I. Sino-atrial node [2]

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II. Atrio-ventricular node [2]

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III. Bundle of His and Purkyne (Purkinje) fibres [2]

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B400U201
03

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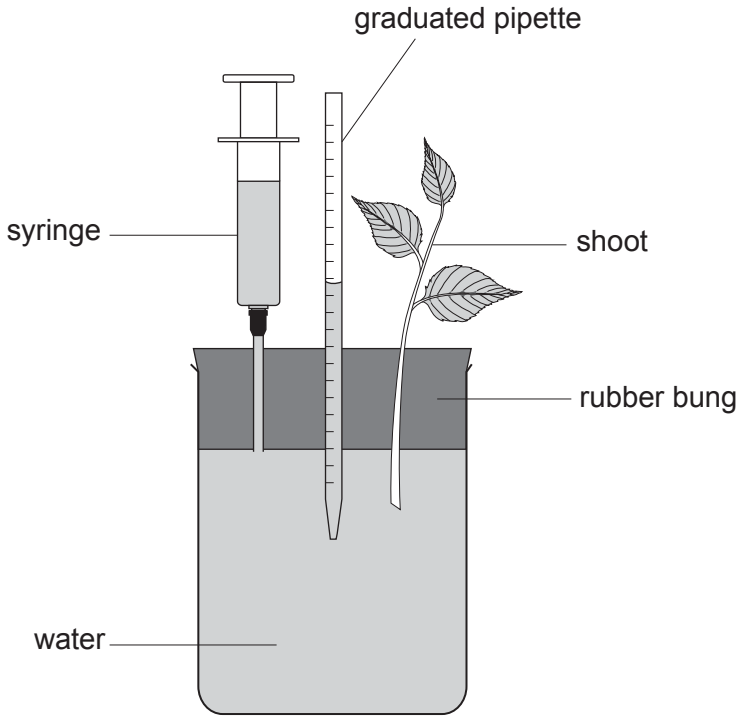
2. A student used the apparatus shown in the diagram below to carry out an investigation into the rate of water uptake by a freshly cut leafy shoot.

With the shoot in place in the apparatus, the level of water in the pipette was recorded every 10 minutes for a total of 40 minutes.

The apparatus was then reset and a transparent polythene bag placed over the leafy shoot. The recordings were then repeated.



(a) (i) Name the apparatus used to measure the rate of water uptake. [1]

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(ii) Why is it important that no air bubbles enter the apparatus? [1]

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(iii) State **two** precautions the student should take when setting up the experiment to ensure that no air bubbles enter the apparatus. [2]

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B400U201
05

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(b) (i) Explain why the temperature and light intensity were controlled during this investigation. [3]

temperature

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light intensity

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Readings were taken and the total volume of water taken up by the leafy shoot was calculated, as shown in the table below.

	Total volume of water taken up by the leafy shoot / cm^3	
Time / minutes	**not enclosed in polythene bag**	**enclosed in polythene bag**
0	0	0
10	2.4	2.2
20	4.1	2.9
30	5.6	2.9
40	6.6	2.9

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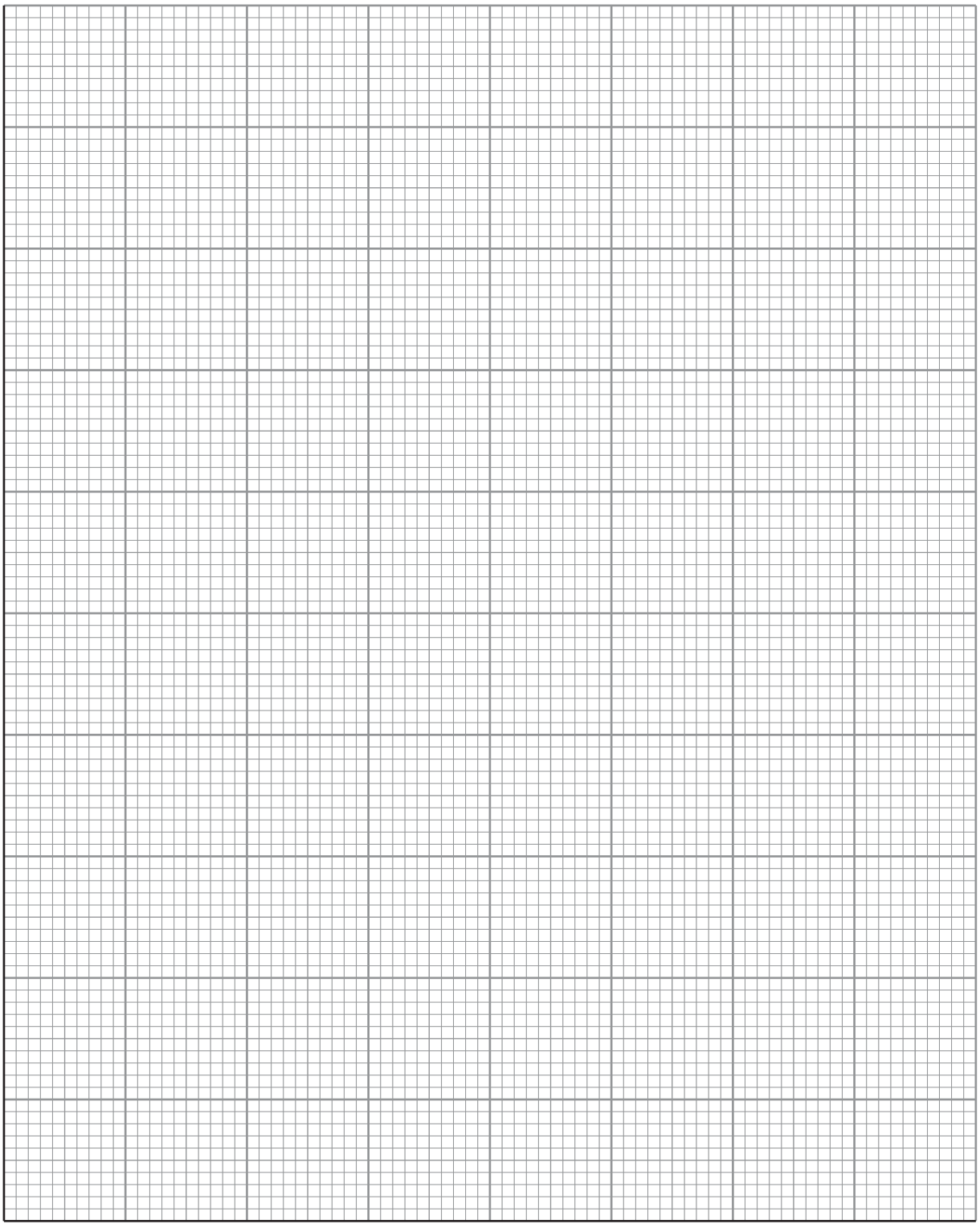
(ii) Plot the results shown in the table opposite on the graph paper below. [4]



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(iii) Describe and explain the results shown. [5]

16

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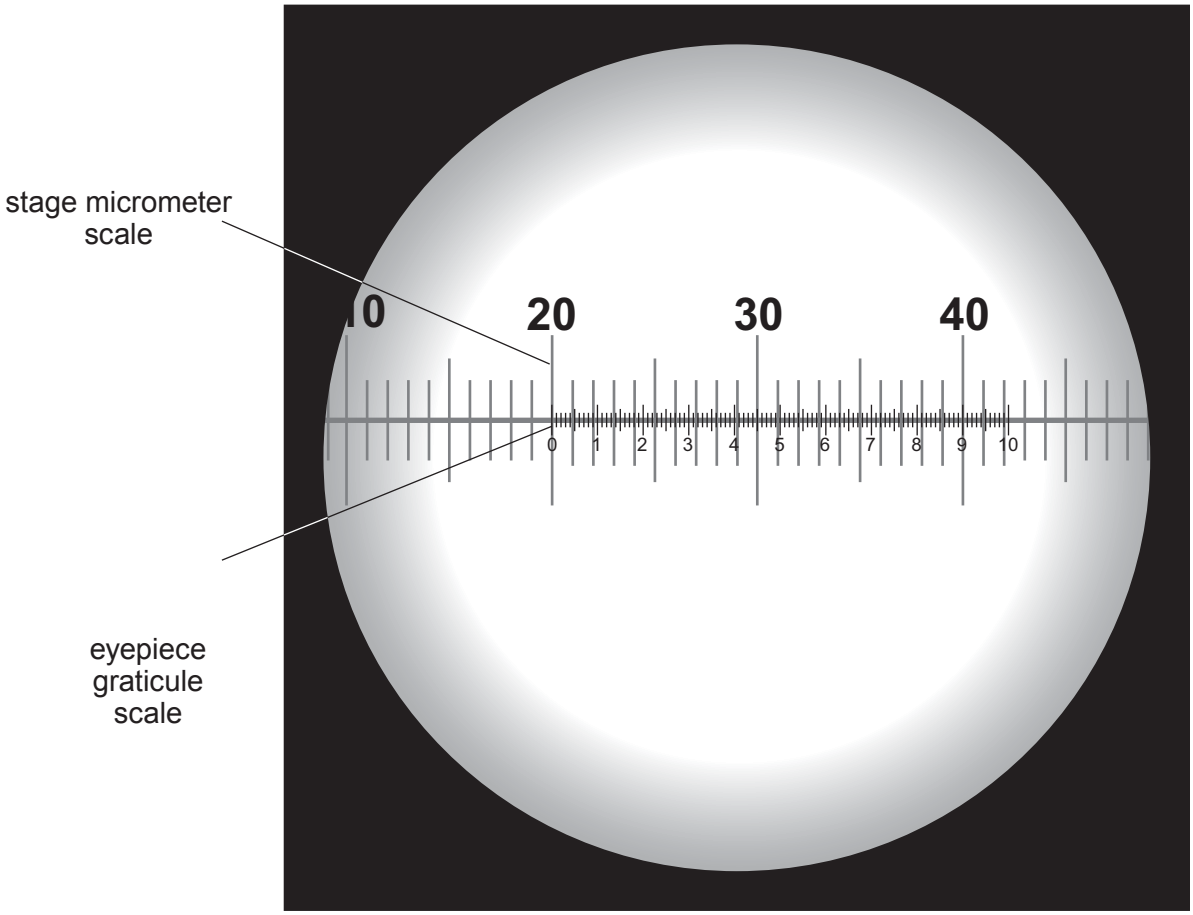
3. A microscope was calibrated at x100 magnification using an eyepiece graticule and stage micrometer, as shown in the image below.

The eyepiece graticule scale shown in the diagram is divided into 100 units. The section labelled 0 – 1 on the image is equal to 10 eyepiece units.



(a) Use this image to calculate the size of 1 eyepiece unit at this magnification. [2]

1 stage micrometer division = 10 µm

1 eyepiece unit = ... µm

B400U201
09

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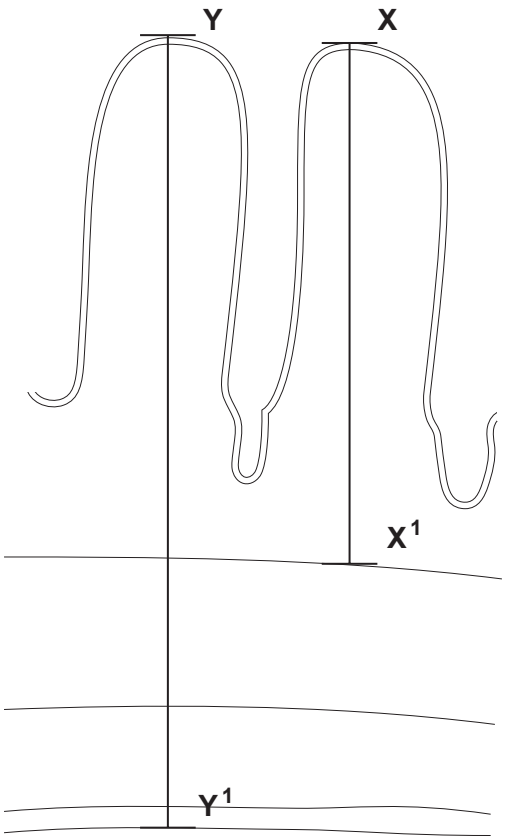
(b) A student used the microscope to examine a T.S. slide of duodenum of a mammal and drew a low power plan.

Low Power Plan of TS Duodenum. (x10 eyepiece lens, x10 objective)



(i) Use clear label lines and the letters **A-D** to identify the following structures on the low power plan above. [4]

A Serosa

B Mucosa

C Circular muscle

D Longitudinal muscle

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(ii) Using the eyepiece graticule, the height of the villus and the thickness of the gut wall were measured at the points indicated. The student recorded the following measurements.

X – X^1 = 20 epu
Y – Y^1 = 25 epu

epu = eye piece unit

Use the answer from *(a)* to calculate the height of the villus marked **X – X^1**. [1]

Height of **X – X^1** = ... µm

(iii) Using the measurement lines shown on the diagram, state if the student's low power plan is in proportion to the actual specimen. Explain how you reached your conclusion. [3]

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B400U201
11

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(c) The protease enzyme trypsin is an endopeptidase secreted by the acinar cells of the pancreas. The enzyme is secreted in an inactive form called trypsinogen. Another enzyme called enterokinase converts the inactive trypsinogen to the active form, trypsin, in the duodenum.

(i) Explain why the enzyme is secreted in an inactive form. [1]

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(ii) The optimum pH of trypsin is in the range 7.8 – 8.7. Explain how this pH is maintained in the duodenum. [3]

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4. Myoglobin is a type of protein that works in a similar way to haemoglobin. It is found inside muscle cells.

The table below shows both the myoglobin concentration and oxygen carrying capacity of skeletal muscle from a variety of terrestrial and marine mammals.

Habitat	Organism	Myoglobin concentration /g kg^{-1} muscle	O_2 carrying capacity /cm^3 kg^{-1} muscle
Terrestrial	Human	6.0	8.0
	Dog	6.7	9.0
	Rat	3.0	4.0
Marine	Harbour porpoise	41.0	56.0
	Harbour seal	52.1	69.8
	Weddell seal	44.6	59.8

(a) A Harbour seal is a marine mammal which lives and hunts for food (mostly fish) in the sea. It is very well suited to its environment and spends long periods of time under water when hunting.

(i) A Harbour seal has a muscle mass of 60% of its total body mass. Calculate the muscle mass of a 70 kg Harbour seal and use this to calculate the total oxygen carrying capacity of its myoglobin. [2]

Total oxygen carrying capacity = ... cm^3

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(ii) A 70 kg human would have an oxygen carrying capacity of approximately 300 cm^3 oxygen bound to myoglobin in their skeletal muscle. Using the data in the table, explain the difference in the oxygen carrying capacity of the muscle of these mammals and suggest how this would be an advantage to the seal. [2]

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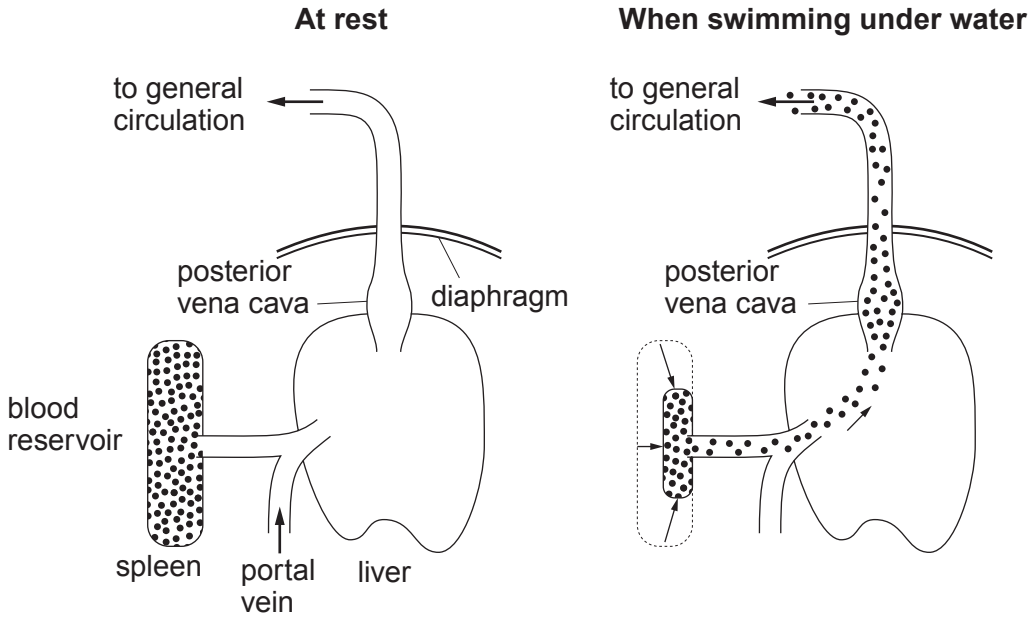
All mammals have an organ, known as the spleen, which acts as a reservoir for blood. When the seal swims under water, the spleen contracts forcing more blood into the general circulation as shown in the diagram below.



(b) Suggest how this adaptation helps the seal stay under water for prolonged periods when hunting its prey. [4]

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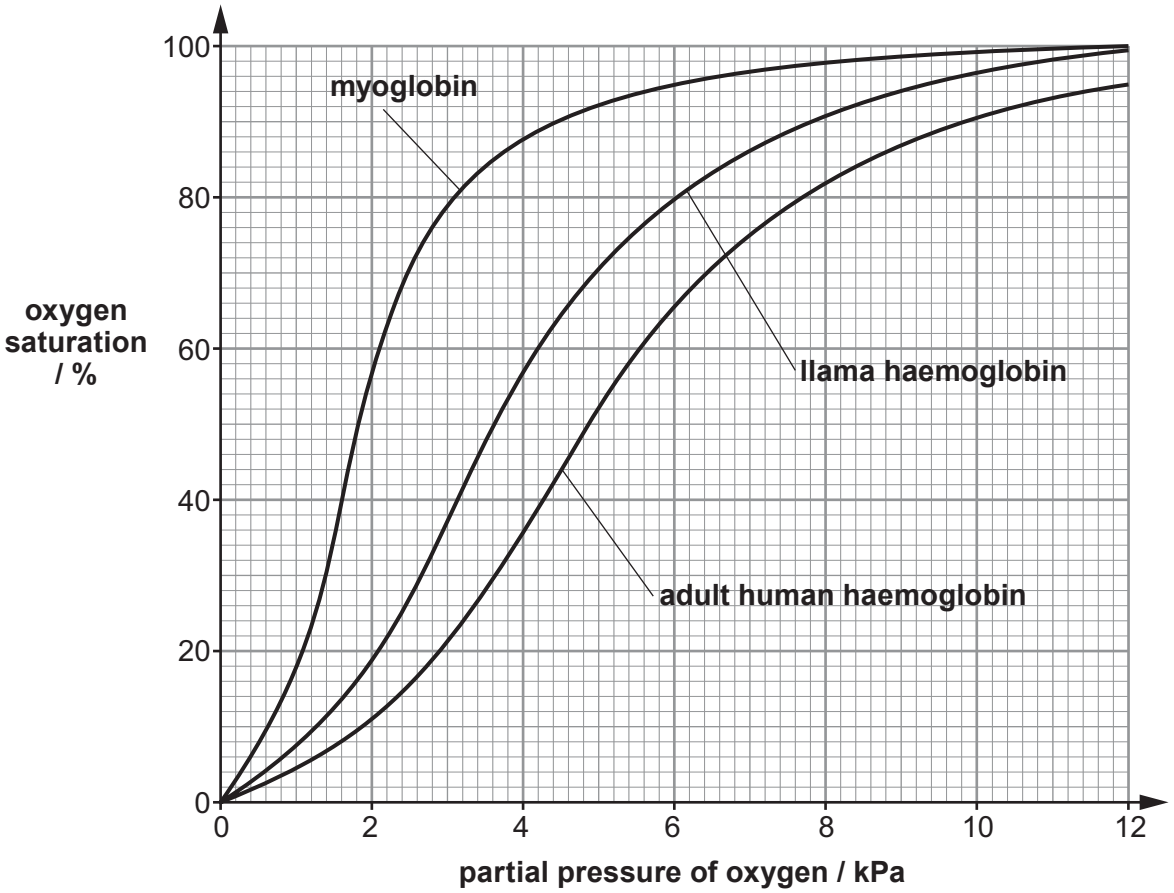
(c) The diagram below shows three dissociation curves.



(i) Explain the significance of the position and shape of the myoglobin curve. [4]

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(ii) Explain the position of the dissociation curve of the llama haemoglobin relative to that of adult human haemoglobin. [2]

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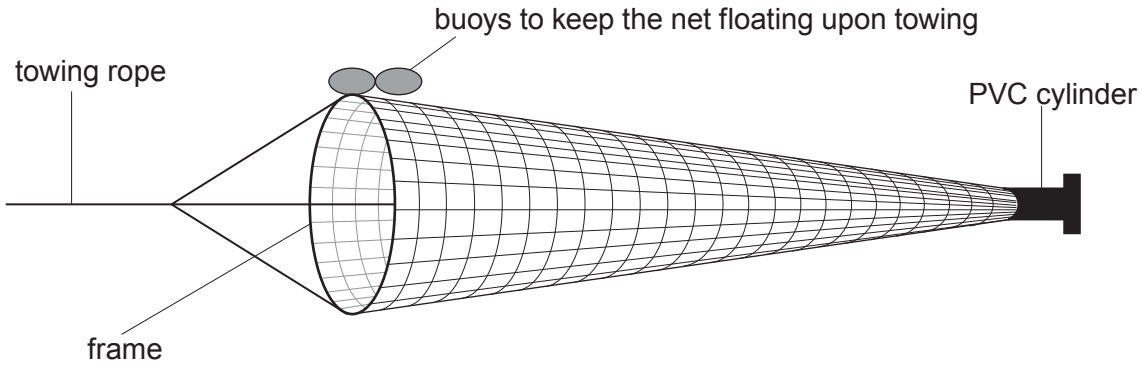
5. Phytoplankton is the term used to describe the microscopic photosynthetic organisms that live in bodies of water, mainly near the surface. They are the main food source of many shellfish and crustaceans. However, some phytoplankton species can produce toxins that accumulate in the tissues and organs of shellfish. If the shellfish are eaten by humans, this can cause a form of food poisoning.
Members of European Union states are required to monitor both the presence and distribution of marine phytoplankton which can produce toxins in areas where shellfish are harvested.

One possible method for estimating the biodiversity of phytoplankton is to use a net to capture the organisms present in a known volume of water. This is then followed by microscopic examination of the organisms to identify them and estimate population numbers.

A diagram of one net used is shown below.



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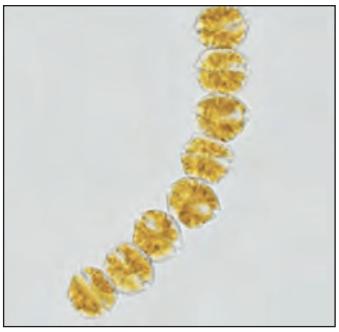
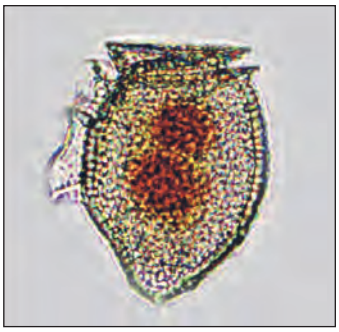
(a) When using this method to catch phytoplankton, the mesh size (size of the holes in the net) for the net has to be chosen carefully. Photomicrographs of three of the most harmful phytoplankton are shown below.

Alexandrium



50 µm

Dinophysis



50 µm

Pseudo-nitzschia

50 µm

Suggest what mesh size would be used to obtain the most accurate count of these phytoplankton. Explain your answer. [2]

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(b) The table below shows the results of monitoring two different sites along a 2 km stretch of coastline for potentially harmful phytoplankton. All samples were taken on the same day using the same sampling method.

phytoplankton	Number of cells at each site / cells dm^{-3}	
	SITE 1	SITE 2
Pseudo-nitzschia	780	49000
Alexandrium	530	0
Dinophysis	650	400
Prorocentrum lima	0	0
Prorocentrum cordatum	420	1480
Lingulodinium polyedrum	0	0
Protoceratium reticulatum	0	20

(i) Use the data to state which site has the greatest biodiversity. Explain your answer. [3]

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(ii) Name a statistical test which could be used to compare the biodiversity of the two sites. [1]

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(iii) The two sites sampled showed significant variation in the distribution of phytoplankton. Suggest improvements to the sampling method in order to further investigate biodiversity along the stretch of coastline. [3]

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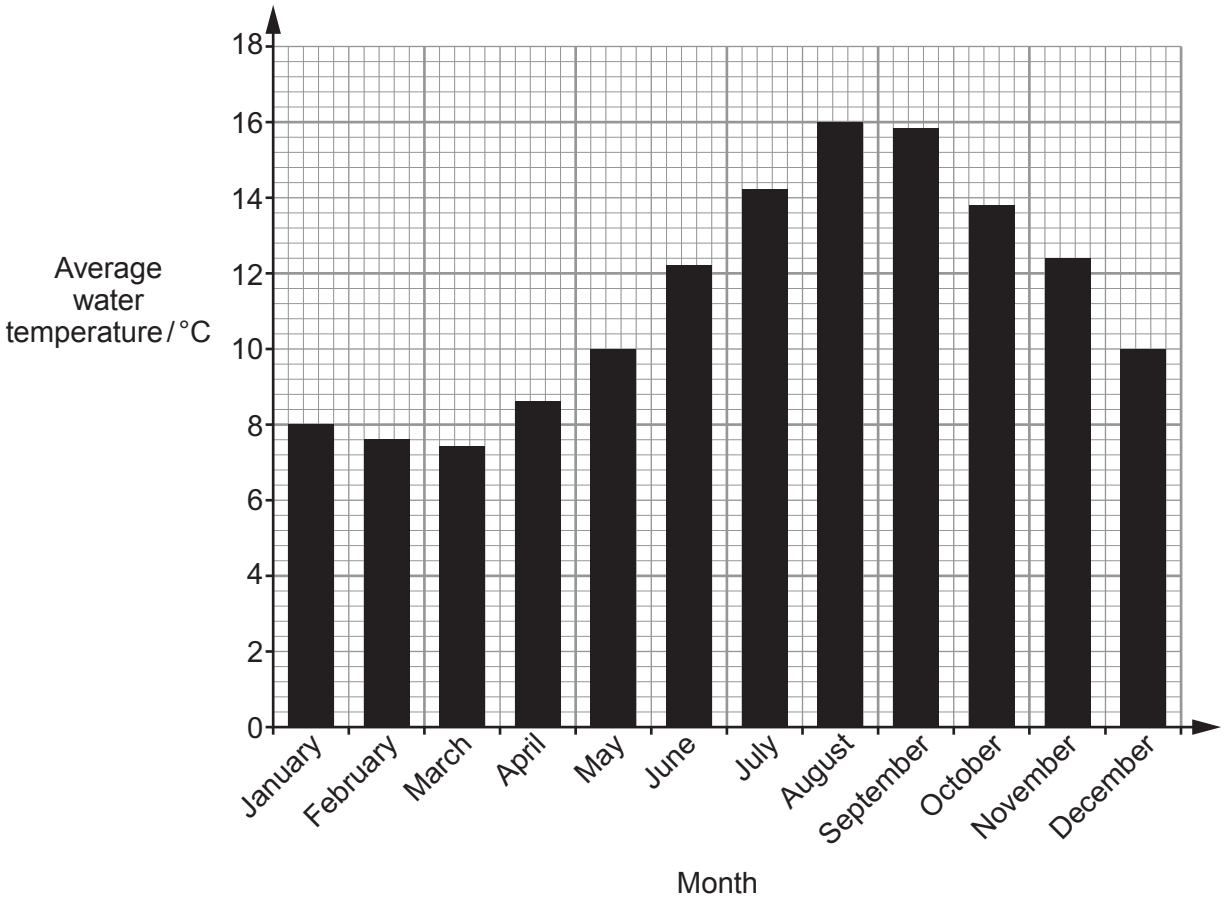
(iv) The data collected from phytoplankton monitoring are used to provide early warnings to the shellfish industry to try to minimise the risk of food poisoning. Phytoplankton levels are monitored at different frequencies throughout the year as shown below:

Time of year	Sampling frequency
March to September	Weekly
October to November	Fortnightly
December to February	Monthly

The Chart below shows the average water temperature at the sampling site.



Explain why monitoring takes place more frequently between March and September. [2]

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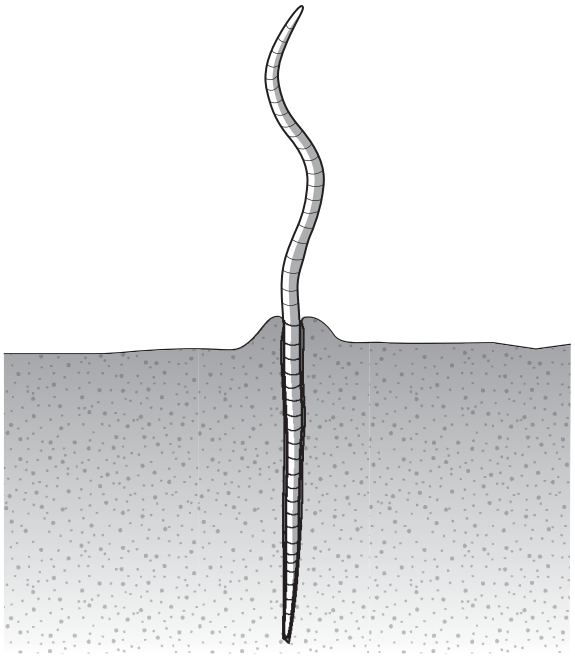
6. *Tubifex* worms have a similar structure to earthworms. They are one of the few multi-cellular organisms that can survive in heavily polluted water which has low oxygen levels. Some of their adaptations to these conditions are described below.

- Diameter of approximately 3 mm, length up to 45 mm.
- Outer body surface is folded.
- Head and front part of body buried in mud – when highly active, less of the body is buried.
- Part of the body exposed to the water moves vigorously.
- Red in colour due to presence of haemoglobin.



Explain how these adaptations enable *Tubifex* worms to survive in water with very low oxygen levels. [9 QER]

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