Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2023

Centre Number

Candidate Number

Biology

Assessment Unit AS 2

assessing

Organisms and Biodiversity

[SBY21]

SBY21

THURSDAY 25 MAY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Section A carries 60 marks. Section B carries 15 marks.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You are reminded of the need for good English and clear presentation in your answers.
Use accurate scientific terminology in all answers.
You should spend approximately **20 minutes** on Section B.
You are expected to answer Section B in continuous prose.
Quality of written communication will be assessed in Section B.

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Section A

1 The five-kingdom classification system includes the kingdoms Plantae, Prokaryotae and Protoctista.

(a) Complete the table below to show the presence (✔) or absence (✘) of various features in each of these kingdoms.

Do not leave any boxes blank.

Kingdom	Feature		
	Cells may contain chloroplasts	**Always unicellular**	**Cell walls made of chitin**
Plantae			
Prokaryotae			
Protoctista			

[3]

(b) In 1990, Carl Woese *et al.* developed the three-domain classification system as an alternative to the five-kingdom system.

Identify which of the five kingdoms has members in both the domain Archaea and domain Bacteria.

_____ [1]

2 The hepatic portal vein connects two major organs in the mammalian digestive system.

(a) Identify the organs linked by the hepatic portal vein.

_____ and _____ [1]

(b) Describe the function of the following structures in a vein:

- Smooth endothelium lining

_____

_____

_____

- Fibrous tissue

_____

_____

_____ [2]

(c) Unlike veins, the walls of arteries have a thick layer of specialised tissue which enables the artery to stretch in response to ventricle contraction. When the ventricles relax, the arteries recoil.

Identify the type of tissue which enables the stretch and recoil response and describe the benefit of the recoil phase.

Type of tissue _____

Benefit of recoil _____

_____ [2]

3 An organism's volume influences its demand for metabolites, such as oxygen and glucose, while the supply of these metabolites is influenced by an organism's surface area.

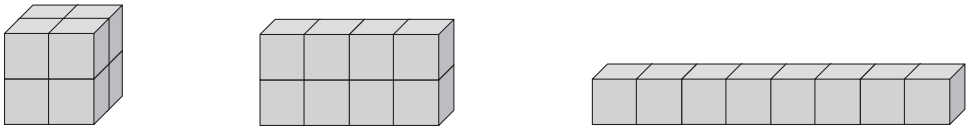
(a) Define what is meant by the surface area of an organism.

_____

_____

_____ [1]

(b) A student wished to determine the relationship between surface area and volume by building three models, **A**, **B** and **C**. Each model was built using eight wooden cubes (of side 1 cm), as shown in the diagram below.



A **B** **C**

(i) For model **C**, calculate the following and complete the table below:

- surface area
- surface area ÷ volume (surface area to volume ratio)

Model	Surface area / cm^2	Volume / cm^3	Surface area ÷ volume
A	24	8	3
B	28	8	3.5
C		8	

[2]

(ii) Suggest and explain which model, **A**, **B** or **C**, represents the body plan of an animal most likely to require specialised internal gas exchange surfaces.

Model _____

Explanation _____

_____

_____ [2]

(c) Gas exchange in mammals occurs in the lungs, between blood in the capillaries and air in the alveoli. Capillary walls and alveolar walls are both composed of squamous cells.

Explain the importance of squamous cells for gas exchange.

_____

_____

_____ [1]

(d) The maximum volume of air in litres which can be taken into the lungs during a full inhalation is called total lung capacity (TLC).

The TLC for 10 individuals is shown in the table.

Age of subject	Sex of subject	TLC / l
22	male	8.43
24	female	5.33
25	male	7.68
26	female	5.34
28	male	7.65
33	female	5.09
35	female	5.72
35	male	6.86
37	male	6.79
40	female	5.63

Identify **two** trends shown by the data.

1. _____

_____

_____

2. _____

_____

_____ [2]

(e) Emphysema is a lung condition in which the walls of the alveoli break down and the total number of alveoli decreases. The elasticity of the alveoli also decreases, making exhalation difficult.

Studies have shown that individuals diagnosed with emphysema tend to have **lower** blood oxygen levels and **higher** TLC values than healthy individuals.

Using the information provided and your knowledge, suggest reasons for these findings.

Lower blood oxygen levels _____

_____

_____

_____

Higher TLC values _____

_____

_____

_____ [3]

4 In multicellular organisms, substances are often transported by mass flow systems.

(a) Explain what causes materials to move by mass flow.

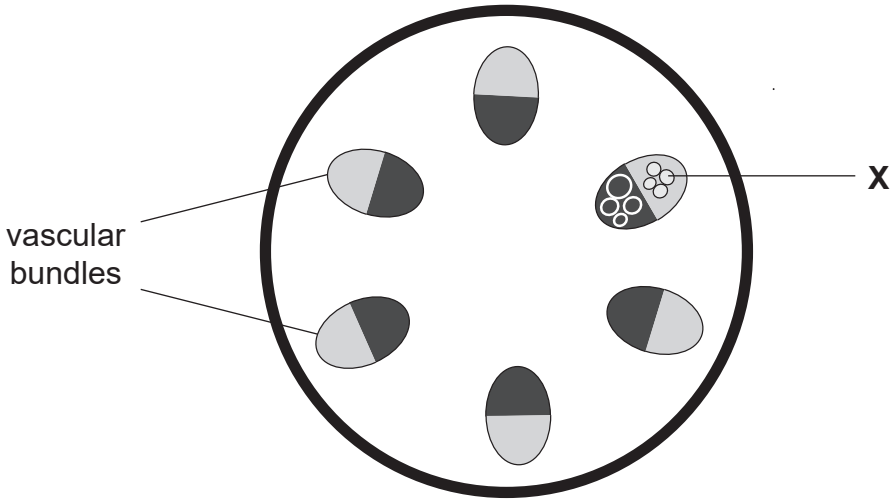
_____

_____

_____ [1]

(b) One mass flow system involves the translocation of organic solutes within plants. This takes place in phloem tissue, which can be located in vascular bundles.

The diagram below represents a transverse section through part of a plant which contains several vascular bundles.



(i) Identify the region of a plant from which this section is taken, and the type of cell which is indicated by **X**.

Region _____

Cell type **X** _____ [2]

(ii) Metabolic inhibitors such as cyanide prevent respiration taking place and have been used to investigate the mechanism of translocation. In the presence of cyanide, the translocation of sucrose is significantly reduced.

State what this observation suggests about the mechanism of translocation.

_____

_____ [1]

(c) Circulation in mammals is another mass flow system. Heart valves help to maintain one-way flow in this system.

(i) Describe concisely what causes the closure of the atrio-ventricular (bicuspid) valve, which occurs after the left ventricle has filled completely with blood.

_____

_____

_____

_____

_____ [2]

(ii) The aortic (semi-lunar) valve is located at the base of the aorta and prevents backflow of blood into the left ventricle.

In some people, the aortic valve leaks and some blood flows back into the left ventricle from the aorta.

The symptoms of this condition include dizziness, lightheadedness and fainting.

Suggest an explanation for these symptoms.

_____

_____

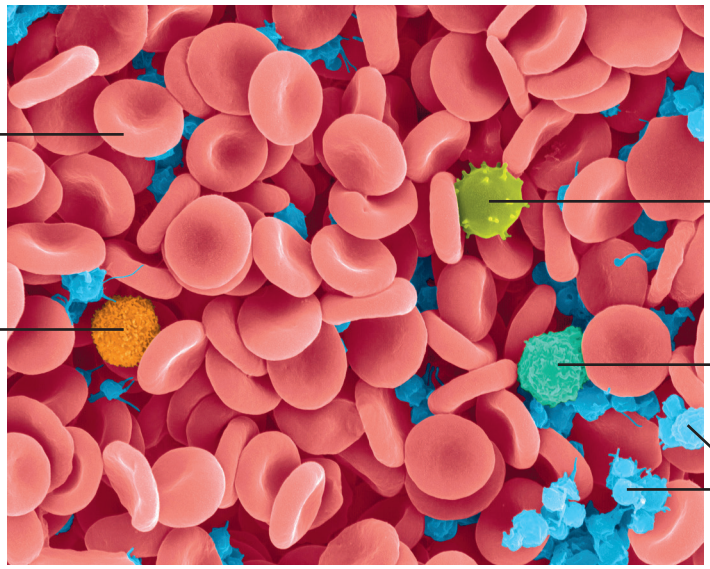
_____

_____

_____ [2]

[Turn over

5 **(a)** A scanning electron micrograph of blood is shown below. Several blood components are labelled.



Source: © Dennis Kunkel Microscopy / Science Photo Library

There are several features of red blood cells which enable them to transport oxygen around the body.

(i) Identify **two** such features of red blood cells which are visible in the electron micrograph.

1. _____

_____

2. _____

_____ [2]

(ii) Select the labelled cells which carry out phagocytosis.

_____

_____ [2]

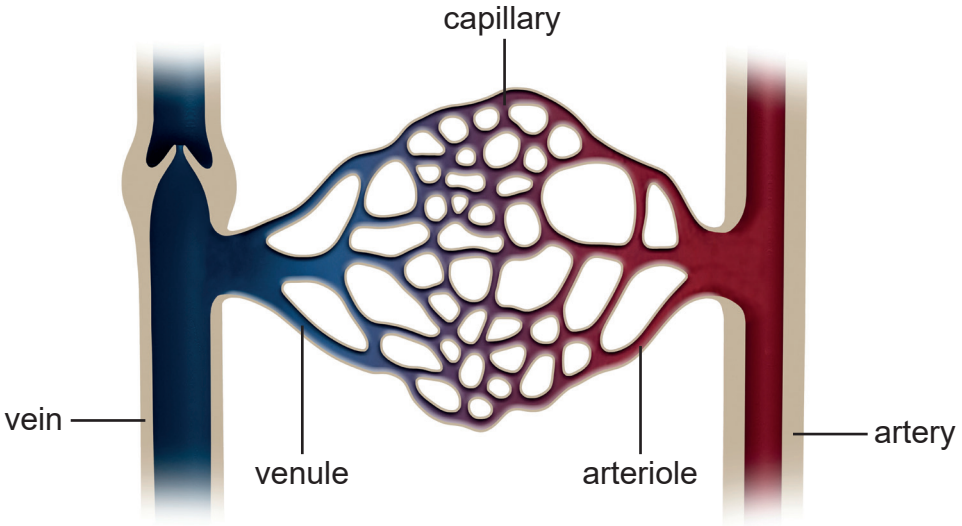
(iii) Polymorphs have several distinctive features which are **not** visible in this electron micrograph. Name one such feature and explain why it is **not** visible in this image.

_____

_____

_____ [2]

(b) Tissue fluid is the liquid which bathes all cells within mammals. It is made up of substances which leave the blood at the arteriole end of capillaries.



Source: © Mikkel Juul Jensen / Science Photo Library

(i) Name a substance which would diffuse to the cells via tissue fluid.

_____ [1]

(ii) At the venule end of capillaries, the pressure difference between tissue fluid and the blood causes some water to re-enter the capillaries.

This pressure difference is referred to as total pressure potential and is calculated as shown below:

Total pressure potential = Hydrostatic pressure + Water potential

	Hydrostatic pressure / kPa	Water potential / kPa	Total pressure potential / kPa
Tissue fluid	2.3	–3.3	–1.0
Capillary (arteriole end)	4.7	–3.3	1.4
Capillary (venule end)	2.1	–3.3	

Using the values in the table above, and the formula provided, calculate the total pressure potential at the venule end of the capillary.

_____ kPa [1]

(iii) Explain why water enters the capillary at the venule end.

_____

_____

_____ [1]

(iv) Suggest why abnormally high blood pressure (hypertension) would lead to a build-up of tissue fluid around the body cells.

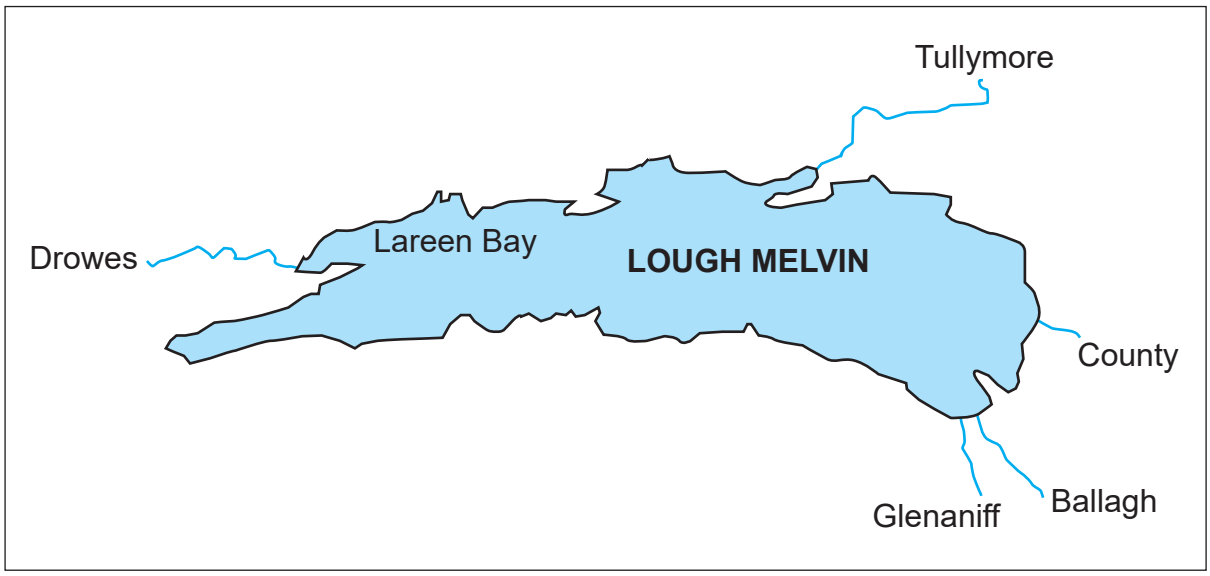
_____

_____

_____

_____ [2]

6 Lough Melvin is a large, freshwater lake located between County Fermanagh and County Leitrim. The map below shows Lough Melvin and its associated rivers. Lough Melvin has been designated as an ASSI.



The lake contains three different types of trout: ferox, gillaroo and sonaghen. Lough Melvin is the only known habitat for sonaghen.

Information about each type of trout is given in the table.

Trout type	Appearance	Diet	Areas in which eggs are laid
Ferox	Dark brown body with black spots	Large and small invertebrates, other fish	Deeper sections of the Glenaniff River
Gillaroo	Golden body with large deep red spots	Snails	Drowes River and Lareen Bay
Sonaghen	Silver body with many large dark spots	Plankton, midge larvae	Ballagh, Tullymore and County Rivers

(a) Using the information provided:

(i) Identify why Lough Melvin has been designated as an ASSI.

_____

_____ [1]

(ii) Identify **two** ways in which competition between the three types of trout is reduced.

1. _____

_____

_____

2. _____

_____

_____ [2]

(b) In order to determine if the three types of trout are distinct species, the fertility of offspring from crosses between two types could be investigated. However, this is difficult and time-consuming to carry out.

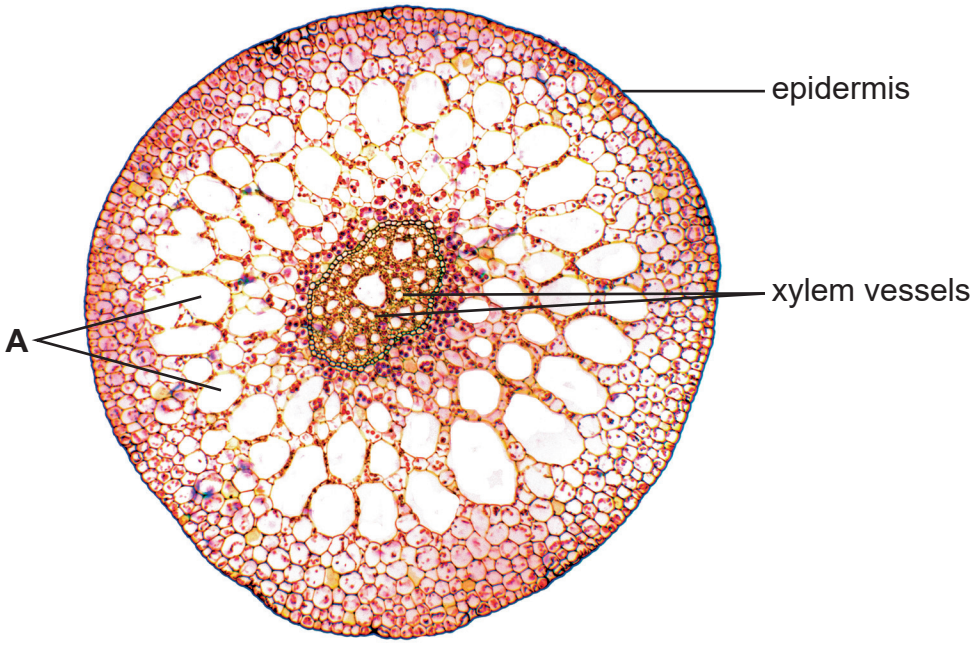
Suggest an alternative method that could be used to investigate how closely related the three types of trout are to each other.

_____

_____ [1]

(c) Lough Melvin also provides a habitat for several uncommon plant species, including Slender-leaved Pondweed (Genus *Potamogeton*). Slender-leaved Pondweed is an aquatic plant and its stems and leaves show typical hydrophytic adaptations.

A transverse section of a stem from a species of *Potamogeton* is shown in the photograph below.



Magnification ×100

Source: © Dr Keith Wheeler / Science Photo Library

(i) Large air spaces are shown labelled **A**. Explain the function of these air spaces in hydrophytes.

_____

_____ [1]

(ii) Suggest why the epidermis in similar sized terrestrial (land) plants is proportionally thicker than that of Slender-leaved Pondweed.

_____

_____

_____ [1]

(iii) Suggest and explain how the structure of xylem vessels in hydrophytes would be expected to differ from those in terrestrial plants.

_____

_____

_____

_____

_____ [2]

(d) Scientists are concerned that the use of artificial fertilisers on fields several miles away from Lough Melvin could have a significant impact on the water quality.

(i) Explain how artificial fertiliser applied to fields several miles away could reach Lough Melvin.

_____

_____

_____

_____ [2]

(ii) Describe how **one** abiotic factor of the water in Lough Melvin could be affected by artificial fertiliser.

_____

_____ [1]

(iii) Slurry is an organic alternative to artificial fertiliser, composed of farm animal waste. Slurry should not be spread within 20 metres of a lake.

Explain why water pollution caused by slurry can have a more immediate effect on aquatic wildlife than pollution caused by artificial fertiliser.

_____

_____

_____

_____

_____ [2]

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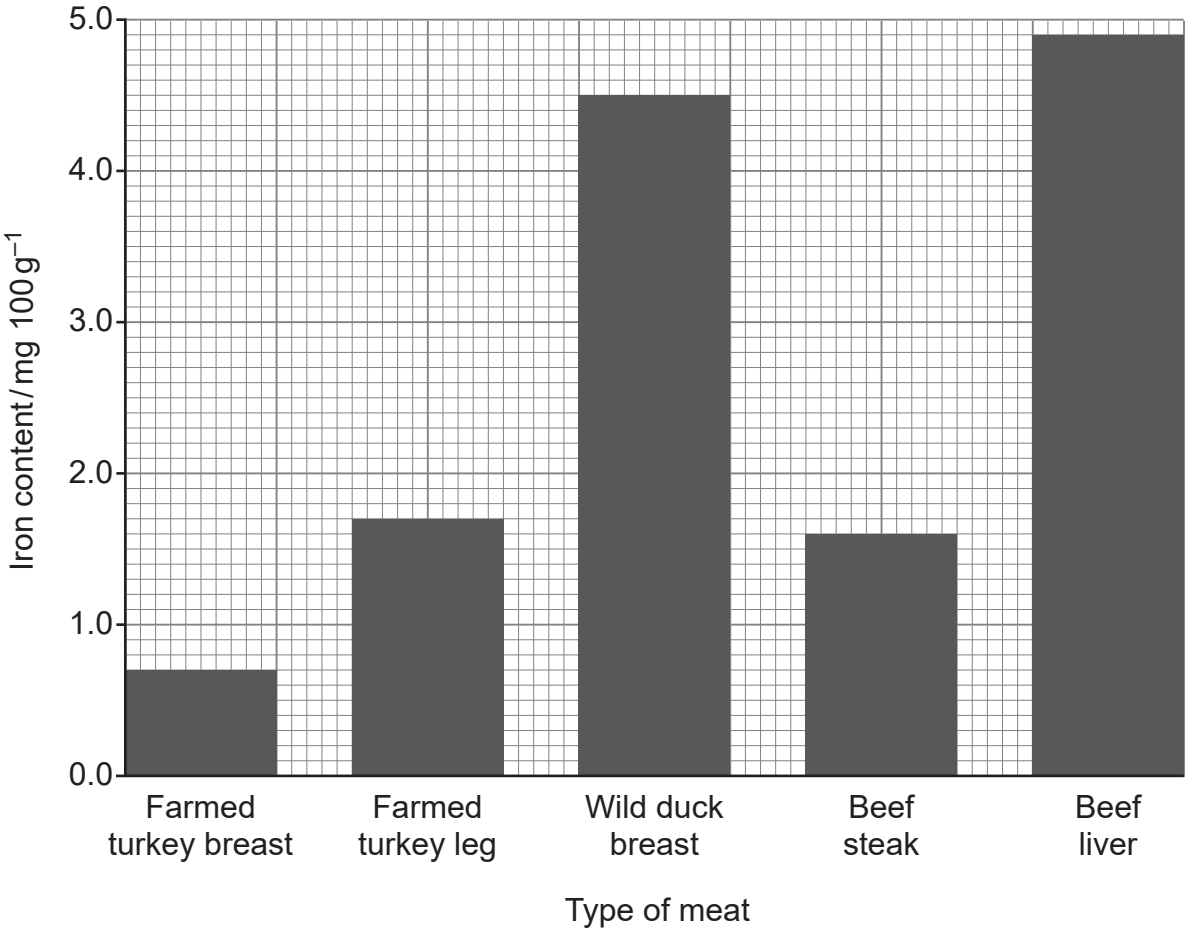
(Questions continue overleaf)

7 Iron is an important component of the human diet, and many people obtain their iron from eating meat. The iron content of various types of meat is shown in the graph below.



(a) (i) Using the data provided, complete the sentence below.

(Show your working.)

Beef liver contains _____ times more iron than farmed turkey breast. [2]

One of the sources of iron in meat is myoglobin, found in muscles. In birds, breast meat mostly consists of the muscles used for flight.

A student suggests the following hypothesis:

Breast meat from wild birds contains more myoglobin than breast meat from farmed birds

(ii) Identify **one** piece of evidence from the graph which supports this hypothesis.

_____

_____ [1]

(iii) With reference to the role of myoglobin in muscle, suggest and explain why myoglobin levels in breast meat from wild birds would be expected to be higher than those in breast meat from farmed birds.

_____

_____

_____

_____ [2]

(b) Myoglobin is an important molecule in the muscles of penguins. Their breast muscles are used for swimming and diving, rather than flight.

The table below shows data collected on three different penguin species.

P_{50} is the partial pressure of oxygen at which myoglobin is 50% saturated. Lower values of P_{50} reflect higher affinity for oxygen.

Species of penguin	**Breast muscle myoglobin concentration / mg g^{-1}**	**P_{50} / Pa**	**Maximum dive depth / m**	**Maximum dive duration / min**
Chinstrap	28	342	121	3
Adelie	30	340	180	4
Emperor	65	333	564	22

(i) Identify the relationship between breast muscle myoglobin concentration and the affinity for oxygen of the penguin myoglobin.

_____

_____

_____ [1]

(ii) Comment on the data to explain why the Emperor penguin can attain a much greater maximum dive depth and duration than the other two species.

_____

_____

_____

_____

_____ [2]

Section B

Quality of written communication will be assessed in this section.

8 Write an account of the pathway and mechanisms of the movement of water into, through and out of a terrestrial plant. [15]

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Question Number	Marks
1	
2	
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8	
Total Marks	

Examiner Number

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