Q1. Scientists studied three species of plant.

They selected fully grown leaves from five different plants of each species.

For each leaf they measured:

- leaf surface area
- leaf thickness
- the number of stomata per mm^2.

The scientists' results are shown in the table below.

Plant species	Mean leaf surface area / mm^2	Mean leaf thickness / µm	Mean number of stomata per mm^2
A	218.0	191.5	380.0
B	17.0	296.3	136.0
C	2.2	354.8	419.0

(a) How did the scientists ensure they could make a valid comparison between leaves from different species?

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(1)

(b) Describe a method you could use to find the surface area of a leaf.

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(3)

(c) (i) Which species, **A** or **B**, would you predict grew in a drier environment?

Explain **one** feature that caused you to choose this species.

Species .....

Explanation .....

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(1)

(ii) Other than the features of leaves in the table above, give **two** features of leaves of xerophytes.

For each feature explain how it reduces water loss.

Feature 1 .....

Explanation .....

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Feature 2 .....

Explanation .....

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(2)

(d) Species **C** has a high number of stomata per mm^2. Despite this it loses a small amount of water.

Use the data to explain why.

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(1)

(Total 8 marks)

Q2. Scientists studied the rate of carbon dioxide uptake by grape plant leaves. Grape leaves have stomata on the lower surface but no stomata on the upper surface.

The scientists recorded the carbon dioxide uptake by grape leaves with three different treatments:

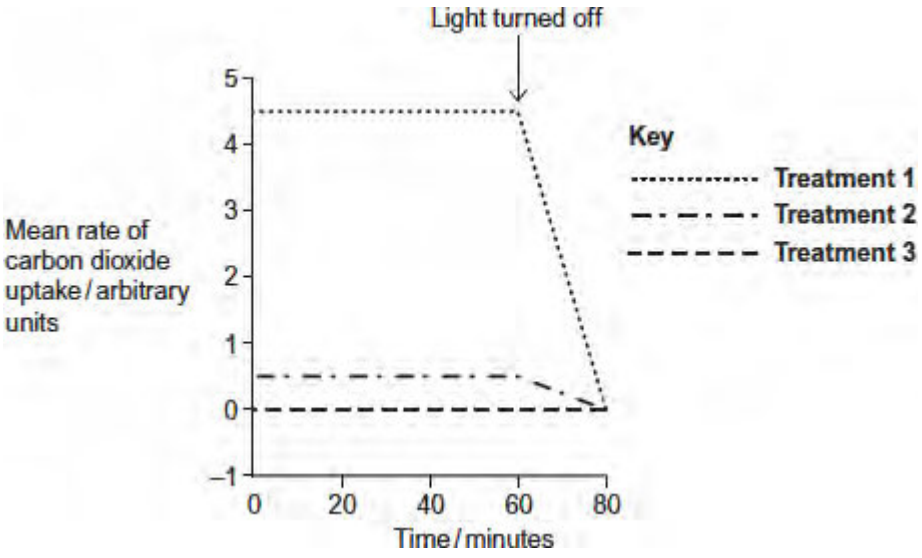
Treatment 1 − No air-sealing grease was applied to either surface of the leaf.

Treatment 2 − The lower surface of the leaf was covered in air-sealing grease that prevents gas exchange.

Treatment 3 − Both the lower surface and the upper surface of the leaf were covered in air–sealing grease that prevents gas exchange.

The scientists measured the rate of carbon dioxide uptake by each leaf for 60 minutes in light and then for 20 minutes in the dark.

The scientists' results are shown in the diagram below.



(a) Suggest the purpose of each of the three leaf treatments.

Treatment 1 .....

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Treatment 2 .....

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Treatment 3 .....

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(3)

(b) (i) Describe the results shown for **Treatment 1**.

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(2)

(ii) The stomata close when the light is turned off.

Explain the advantage of this to the plant.

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(2)

(c) (i) **Treatment 2** shows that even when the lower surface of the leaf is sealed there is still some uptake of carbon dioxide.

Suggest how this uptake of carbon dioxide continues.

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(1)

(ii) In both **Treatment 1** and **Treatment 2**, the uptake of carbon dioxide falls to zero when the light is turned off.

Explain why.

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(2)
(Total 10 marks)

Q3. A scientist used grasshoppers to investigate the effect of composition of air on breathing rate in insects. He changed the composition of air they breathed in by varying the concentrations of oxygen and carbon dioxide.

The scientist collected 20 mature grasshoppers from a meadow. He placed the grasshoppers in a small chamber where he could adjust and control the composition of air surrounding them. The small chamber restricted the movement of the grasshoppers.

His results for three of the grasshoppers are shown in the table below in the form in which he presented them.

		Percentage of oxygen and carbon dioxide in different types of air breathed in by grasshoppers			
		A Air from atmosphere	**B Pure oxygen**	**C Gas mixture 1**	**D Gas mixture 2**
Gas	**Oxygen**	20.9	100.0	91.0	84.0
	Carbon dioxide	0.1	0.0	9.0	16.0
Breathing rate of grasshopper in different	**Grasshopper 1**	53	11	99	107
	Grasshopper	48	25	88	99

types of air / breaths per minute	**2**				
	Grasshopper 3	61	13	96	93

(a) The percentages of oxygen and carbon dioxide in Column **A** do **not** add up to 100% but in columns **C** and **D** they do.
Suggest **two** reasons for this difference.

1 .....

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2 .....

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(2)

(b) Use all the data to describe the effect of concentration of carbon dioxide on the breathing rate of grasshoppers.

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[Extra space] .....

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(3)

(c) One of the different types of air was similar to the air in the meadow where the grasshoppers were collected. It provides data that might be used to calculate a mean breathing rate for grasshoppers in the meadow.

(i) Use the data to estimate the mean breathing rate of the three grasshoppers in the meadow. Show your working.

Mean breathing rate = ... breaths per minute

(2)

(ii) The estimate does not provide a reliable value for the mean breathing rate of all insect species in the meadow.
Other than being an estimate, suggest and explain **three** reasons why this value would **not** be reliable.

1 .....

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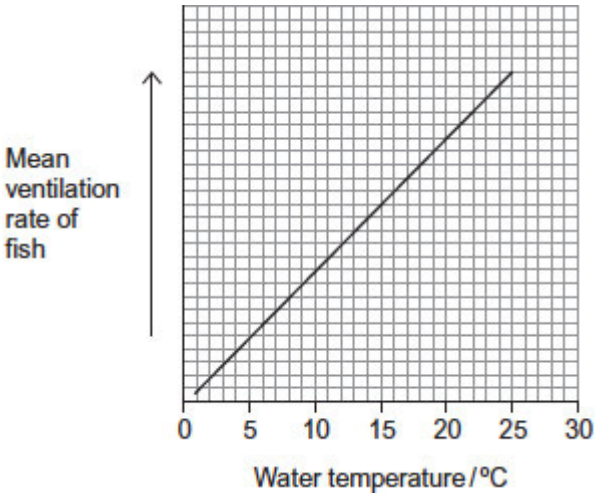
(3)
(Total 10 marks)

Q4. A biologist investigated the effect of water temperature on the rate of ventilation of gills in a species of fish. She kept four fish in a thermostatically controlled aquarium and measured the mean ventilation rate by counting movements of their gill covers.

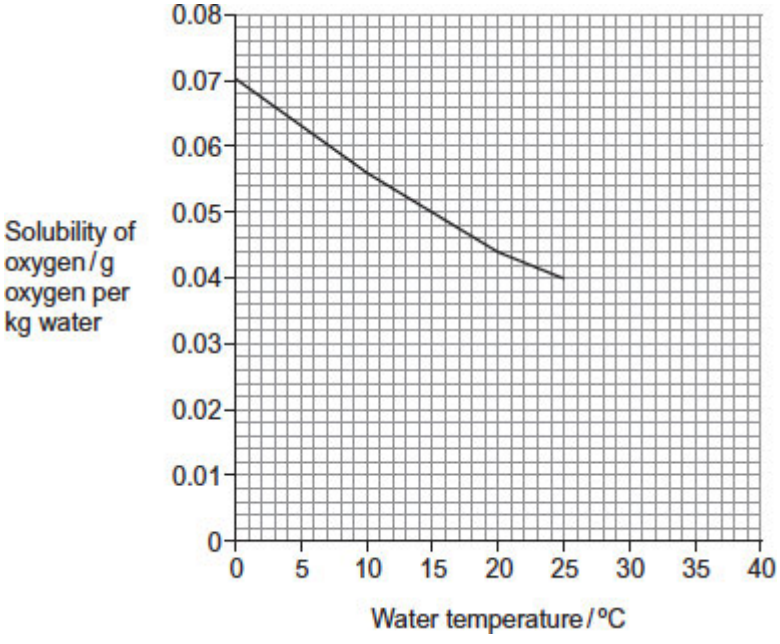
Her results are shown in **Figure 1**.

Figure 1



In this investigation, the biologist also monitored the concentration of oxygen in the water in the aquarium. The concentration of oxygen in water changes with temperature of the water. **Figure 2** shows how it changes.

Figure 2



(a) Suggest a difficulty of counting movements of gill covers as a method of measuring rate of ventilation in fish.

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(1)

(b) The biologist concluded that there was a correlation between rate of ventilation of the gills and temperature of the water. A scatter diagram can be used to look for a

correlation but, in this investigation, it was **not** the appropriate graph for her data. Explain why.

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(1)

(c) (i) Describe the relationship between temperature of water, oxygen in water and rate of ventilation.

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(1)

(ii) Use **Figure 1** and **Figure 2** to explain the advantage to the fish of the change in its rate of ventilation.

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[Extra space] .....

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(3)
(Total 6 marks)

Q5. Breathing out as hard as you can is called forced expiration.

(a) Describe and explain the mechanism that causes forced expiration.

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(4)

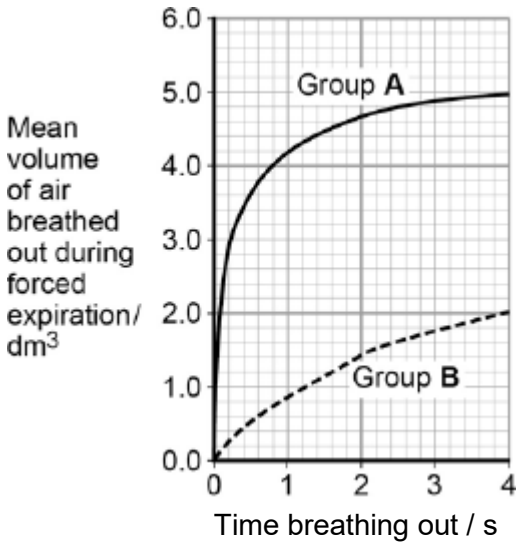
Two groups of people volunteered to take part in an experiment.

- People in group **A** were healthy.
- People in group **B** were recovering from an asthma attack.

Each person breathed in as deeply as they could. They then breathed out by forced expiration.

A scientist measured the volume of air breathed out during forced expiration by each person.

The graph below shows the results.



(b) Forced expiration volume (FEV) is the volume of air a person can breathe out in1 second.

Using data from the first second of forced expiration, calculate the percentage decrease in the FEV for group **B** compared with group **A**.

Answer = ... %

(1)

(c) The people in group **B** were recovering from an asthma attack.
Explain how an asthma attack caused the drop in the mean FEV shown in the figure below.

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(Extra space) .....

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(4)
(Total 9 marks)

Q6.(a) Describe how oxygen in the air reaches capillaries surrounding alveoli in the lungs.
Details of breathing are **not** required.

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(Extra space) .....

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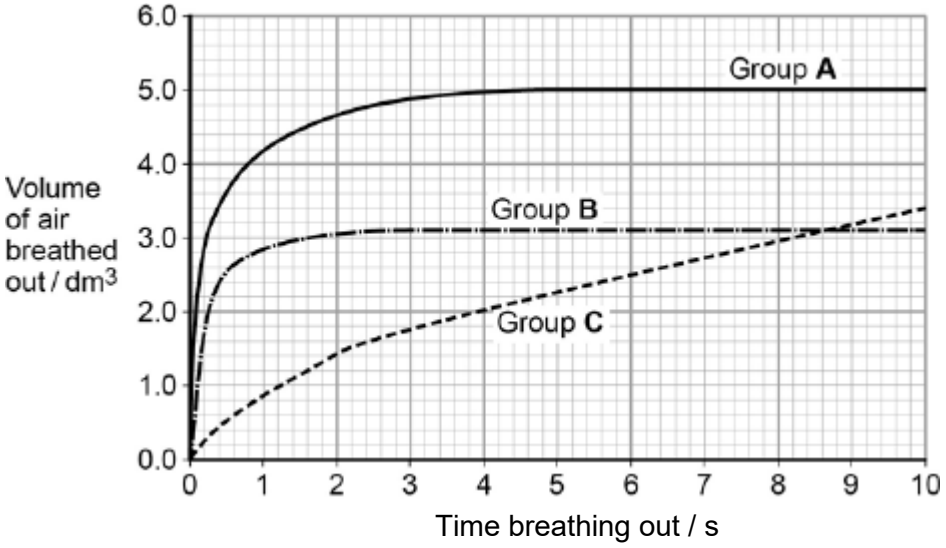
(4)

Forced expiratory volume (FEV) is the greatest volume of air a person can breathe out in 1 second.

Forced vital capacity (FVC) is the greatest volume of air a person can breathe out in a single breath.

The figure below shows results for the volume of air breathed out by three groups of people, **A**, **B** and **C**. Group **A** had healthy lungs. Groups **B** and **C** had different lung conditions that affect breathing.



(b) Calculate the percentage drop in FEV for group **C** compared with the healthy people.

Answer = ...

(1)

(c) Asthma affects bronchioles and reduces flow of air in and out of the lungs. Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, **B** or **C**, was the one containing people with fibrosis of their lungs? Use the information provided and evidence from the figure above to explain your answer.

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(Extra space) .....

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(3)
(Total 8 marks)

Q7.(a) Describe and explain how the countercurrent system leads to efficient gas exchange across the gills of a fish.

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(Extra space) .....

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(3)

(b) Amoebic gill disease (AGD) is caused by a parasite that lives on the gills of some species of fish. The disease causes the lamellae to become thicker and to fuse together.

AGD reduces the efficiency of gas exchange in fish. Give **two** reasons why.

1 .....

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2 .....

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(2)

(c) The table below shows some features of gas exchange of a fish at rest.

Volume of oxygen absorbed by the gills from each dm^3 of water / cm^3	7
Mass of fish / kg	0.4
Oxygen required by fish / $cm^3\ kg^{-1}\ hour^{-1}$	90

(i) Calculate the volume of water that would have to pass over the gills each hour to supply the oxygen required by the fish. Show your working.

..... dm^3

(2)

(ii) The volume of water passing over the gills increases if the temperature of the water increases. Suggest why.

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(1)
(Total 8 marks)

Q8.(a) (i) Name the process by which oxygen passes from an alveolus in the lungs into the blood.

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(1)

(ii) Describe **two** adaptations of the structure of alveoli for efficient gas exchange.

1.....

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2.....

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(2)

(b)

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The photograph shows a fire-breather creating a ball of fire. Fire-breathers do this by blowing a fine mist of paraffin oil onto a flame. Some of this mist can be inhaled and may eventually lead to fibrosis.

People who have been fire-breathers for many years often find they cannot breathe out properly. Explain why.

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(2)
(Total 5 marks)