AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.3.2 GAS EXCHANGE

SCORE	PERCENTAGE
/443	%

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Q1.

(a) Describe the pathway taken by an oxygen molecule from an alveolus to the blood.

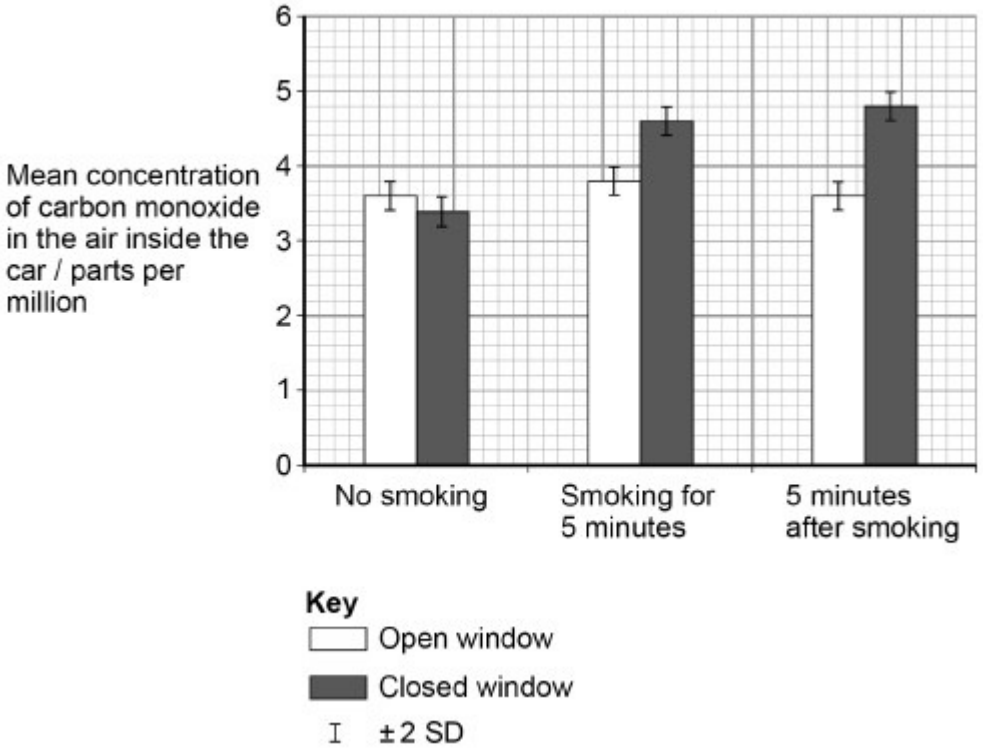
(2)

(b) Explain how **one** feature of an alveolus allows efficient gas exchange to occur.

(2)

Carbon monoxide is a poisonous gas that is present in cigarette smoke. This carbon monoxide can be absorbed into the blood where it binds with haemoglobin.

Scientists investigated the concentration of carbon monoxide in cars in which people were smoking or not smoking. They measured the concentration with the car windows open and closed. The graph shows the scientists' results as they presented them. A value of ± 2 standard deviations from the mean includes over 95% of the data.



(c) In England, in October 2015, a law was introduced making it illegal to smoke in a car carrying someone who is under the age of 18.

Following the introduction of the law, a politician stated:

'It is dangerous to smoke when a child is in the car. Higher levels of deadly toxins can build up, even on short journeys, and children breathe faster than adults, meaning they inhale more of the deadly toxins.'

Use the information provided **and** the data in the graph to evaluate the politician's statements.

(4)
(Total 8 marks)

Q2.

(a) Describe the gross structure of the human gas exchange system and how we breathe in and out.

(6)

(b) Mucus produced by epithelial cells in the human gas exchange system contains triglycerides and phospholipids.

Compare and contrast the structure **and** properties of triglycerides and phospholipids.

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(5)

(c) Mucus also contains glycoproteins. One of these glycoproteins is a polypeptide with the sugar, lactose, attached.

Describe how lactose is formed and where in the cell it would be attached to a polypeptide to form a glycoprotein.

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(4)

(Total 15 marks)

Q3.

Stomata are found mainly on the underside of leaves of dicotyledonous plants.
A student painted a layer of nail varnish on the lower epidermis of a leaf.
She peeled off the dry layer of nail varnish and placed it on a microscope slide. The student was able to see the impressions of the stomata on the varnish using an optical microscope.
She then determined the mean diameter of the stomata.

(a) Describe how the student could use an eyepiece graticule to determine the mean diameter of stomata.

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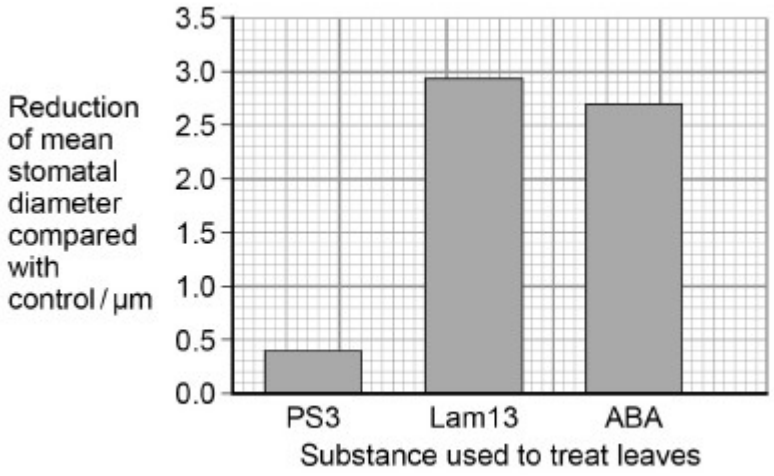
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(3)

A scientist investigated the effect of treating the leaves of one species of plant with three different substances. These substances **reduce** the stomatal diameter. He compared the mean diameter of stomata after treating the leaves with these substances with the mean stomatal diameter on control leaves treated with distilled water.

The scientist's results are shown in the graph below.
The mean stomatal diameter of the control leaves was 7.5 µm.



(b) Calculate the ratio of mean stomatal diameter of leaves treated with PS3 to those treated with ABA.

Answer = _____ : 1

(2)

(c) ABA is a substance that some plant species produce when little water is available.

Explain why producing ABA may help these species survive in dry conditions.

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_____

_____

_____

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(2)

(d) Many species of plants can be infected by powdery mildew which is spread by microscopic spores in the air.

Suggest how treatment with Lam13 might protect plants against powdery mildew infection.

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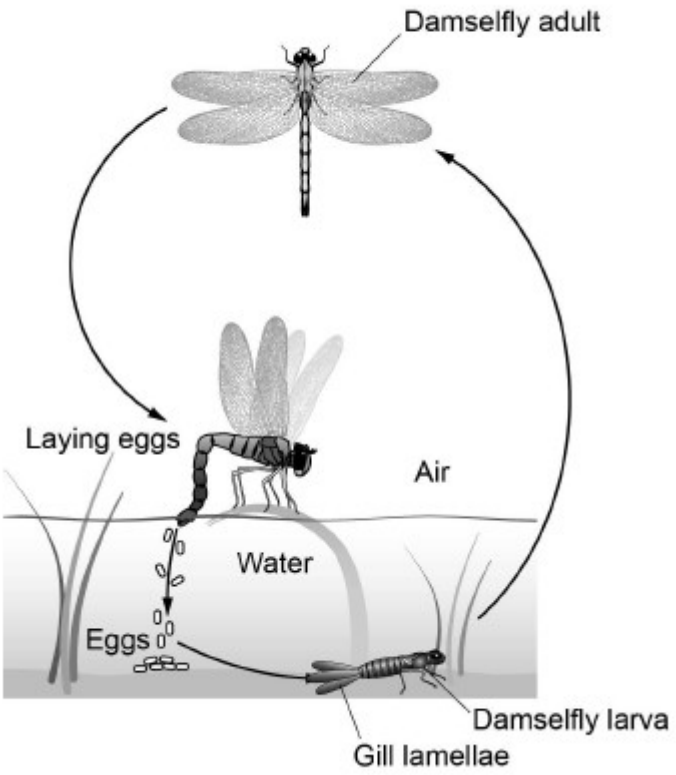
(1)

(Total 8 marks)

Q4.

Figure 1 shows the stages of development of an insect called a damselfly.

Figure 1



(a) The adult damselfly uses a tracheal system for gas exchange.

Explain **three** ways in which an insect's tracheal system is adapted for efficient gas exchange.

1. _____

_____

_____

2. _____

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3. _____

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(3)

(b) The damselfly larva is a carnivore that actively hunts prey. It has gills to obtain oxygen from water.

Some other species of insect have larvae that are a similar size and shape to damselfly larvae and also live in water. These larvae do **not** actively hunt prey and do **not** have gills.

Explain how the presence of gills adapts the damselfly to its way of life.

_____

_____

_____

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_____

(2)

(c) A scientist measured the size of each gill lamella of the gills of 40 damselfly larvae. His results are shown in the table.

Mean width / mm (± uncertainty / mm)	1.61 (± 0.19)
Mean width / mm (± uncertainty / mm)	6.12 (± 0.41)

Calculate the mean surface area of **one side** of one gill lamella. Assume that a gill lamella is rectangular and give your answer to an **appropriate number of significant figures**.

Include the percentage error (uncertainty) of surface area in your answer.
Show your working.

Mean surface area = _____

Percentage error (uncertainty) of surface area = _____

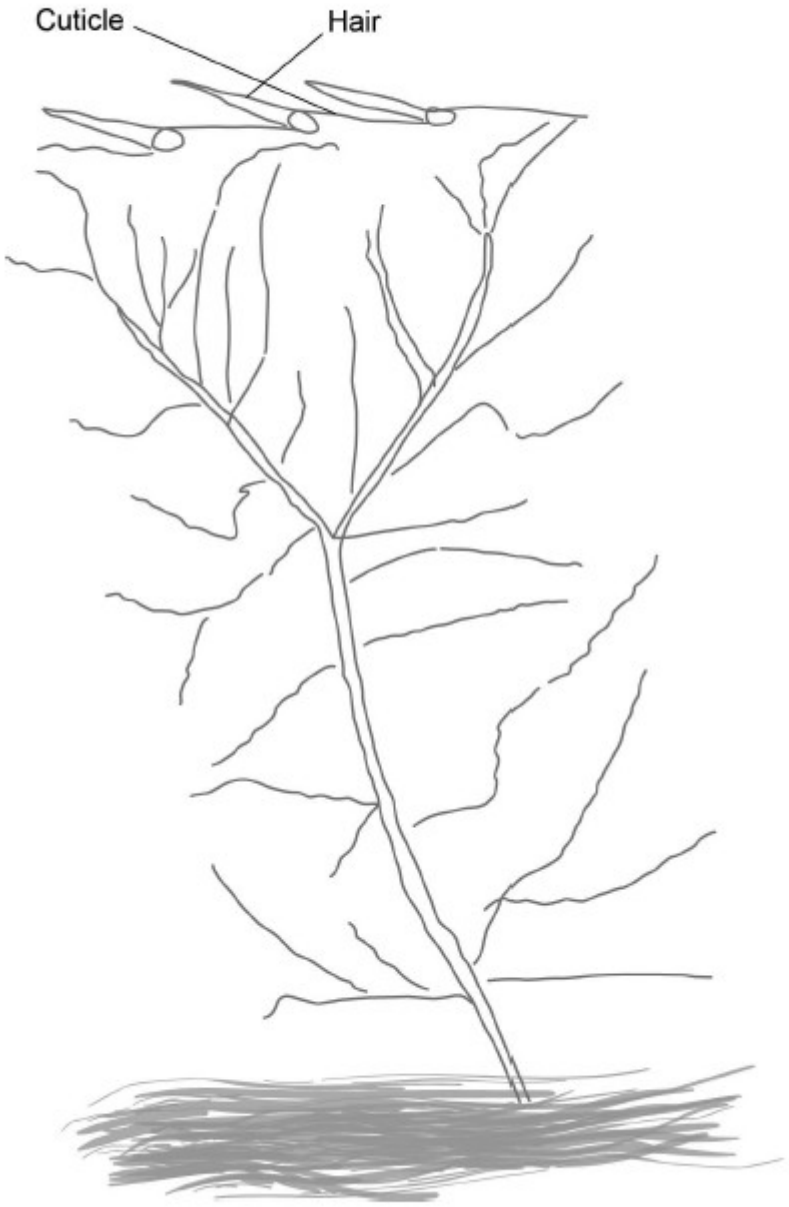
(3)

(d) A student used an optical microscope to observe part of a damselfly larva gill.

Figure 2 shows the drawing the student produced.

Figure 2

Part of a damselfly larva's gill



Suggest **two** ways the student could improve the quality of her scientific drawing of this gill.

1. _____

_____

_____

2. _____

_____

_____

(2)

(Total 10 marks)

Q5.

(a) Explain **two** ways in which the structure of fish gills is adapted for efficient gas exchange.

1. _____

_____

2. _____

_____

(2)

(b) Explain how the counter current mechanism in fish gills ensures the maximum amount of the oxygen passes into the blood flowing through the gills.

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(3)

(Total 5 marks)

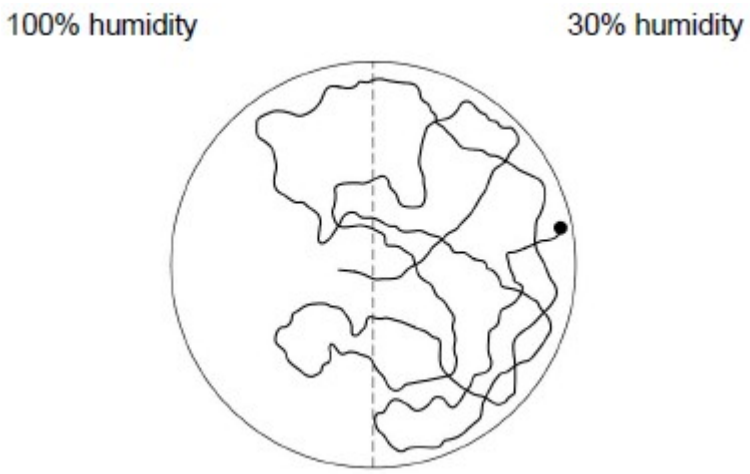
Q6.

Scientists investigated the effect of humidity on the movement of the insect, *Tenebrio molitor*.
The insects were placed in choice chambers with one side kept at 100% humidity and the other side kept at 30% humidity.

The insects were used one at a time and the path the insect followed recorded on paper.

Figure 1 shows a typical result. The solid dot shows the final recorded position of the insect.

Figure 1



(a) What type of behaviour was shown by the insect in **Figure 1**?

Give evidence from **Figure 1** to support your answer.

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_____

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(2)

(b) The scientists found that the insects moved for 94% of the time in the more humid side, but in the drier side they moved only 20% of the time. The scientists concluded that reduced movement in the drier side was an adaptation that reduced water loss.

Use your knowledge of gas exchange in insects to explain how this behaviour would reduce water loss in the insects.

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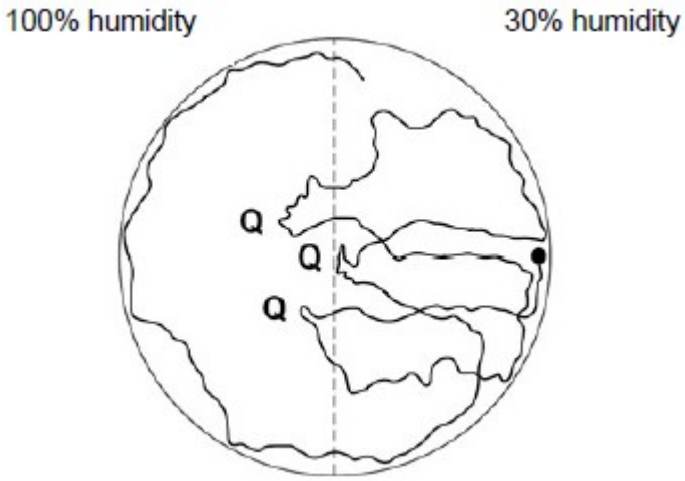
(2)

(c) *Tenebrio molitor* has two antennae on its head. These are sense organs.

The scientists found that one insect stopped when it reached the boundary between the two sides of the choice chamber and seemed to perform various movements with its antennae. The insect then moved to the drier side.

This behaviour can be seen in **Figure 2**. The points marked with a **Q** indicate where the insect showed this behaviour.

Figure 2



What type of behaviour did the scientists conclude that the insect in **Figure 2** was showing?

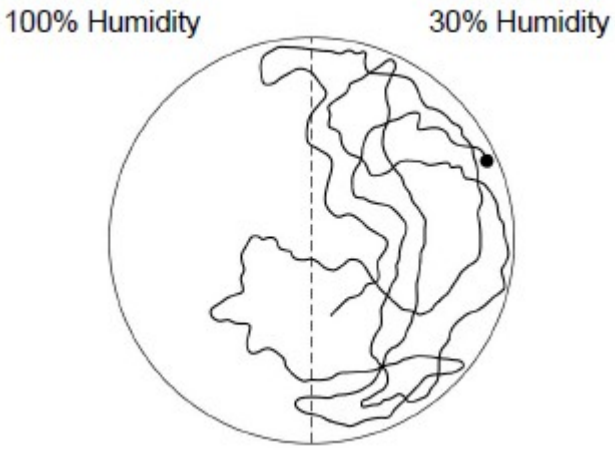
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(1)

(d) After observing the behaviour of the insect in **Figure 2**, the scientists hypothesised that if an insect had one of its antennae removed it would have a tendency to turn to one side and move in circles. The scientists tested this hypothesis by cutting one antenna off another insect and observing its movement.

The result of this experiment can be seen in **Figure 3**.

Figure 3



Does the movement observed in **Figure 3** support the scientists' hypothesis?

Give the reason for your answer.

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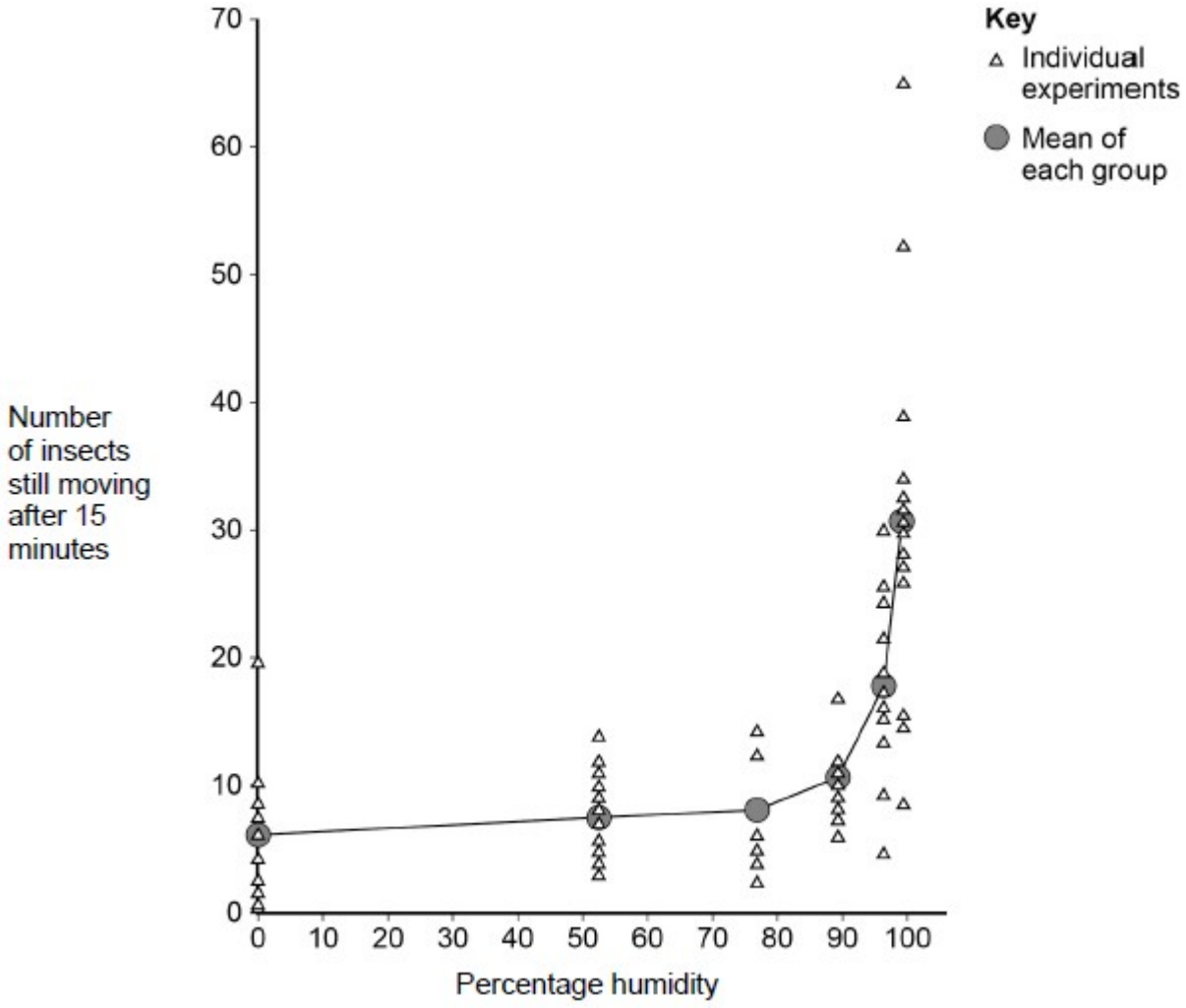
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(2)

(e) The scientists then investigated the effect of a range of humidities on the activity of the insects. **Figure 4** shows their results. The triangles represent the number of insects still moving after 15 minutes.

Figure 4



A student studying **Figure 4** concluded that as humidity increases, so does movement of the insects.

Evaluate the student's conclusion.

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(2)

(Total 9 marks)

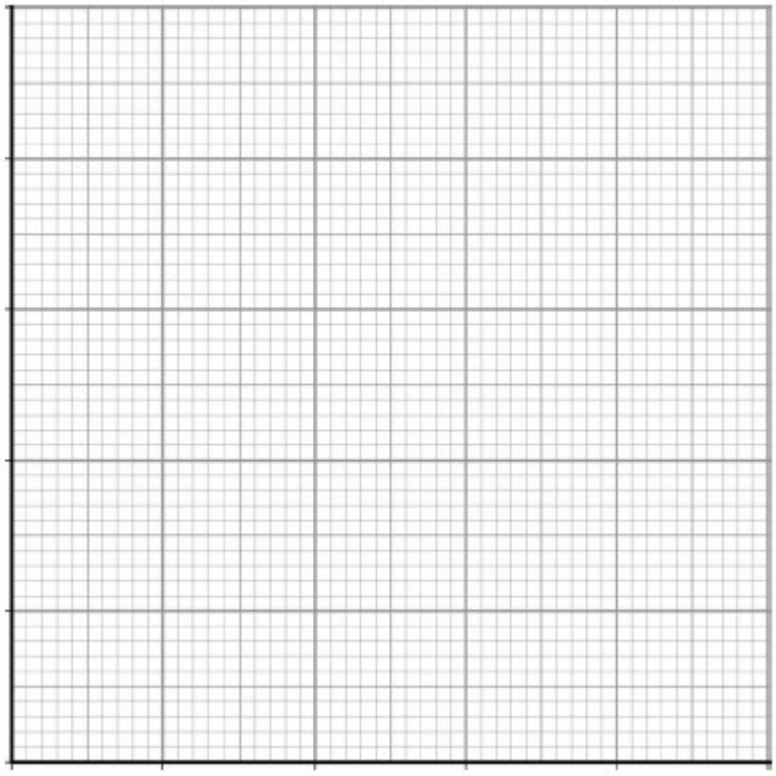
Q7.

Scientists measured the rate of carbon dioxide release by three groups of insects of the same species at 10 °C, 20 °C and 30 °C. They also determined the mean mass of each group of insects.

The scientists results are shown in the table.

Temperature / °C	**Mean mass / g**	**Rate of carbon dioxide release / μdm^3 $minute^{-1}$**	**Rate of carbon dioxide release per gram / μdm^3 g^{-1} $minute^{-1}$**
10	0.047	0.12	
20	0.046	0.33	
30	0.048	0.56	

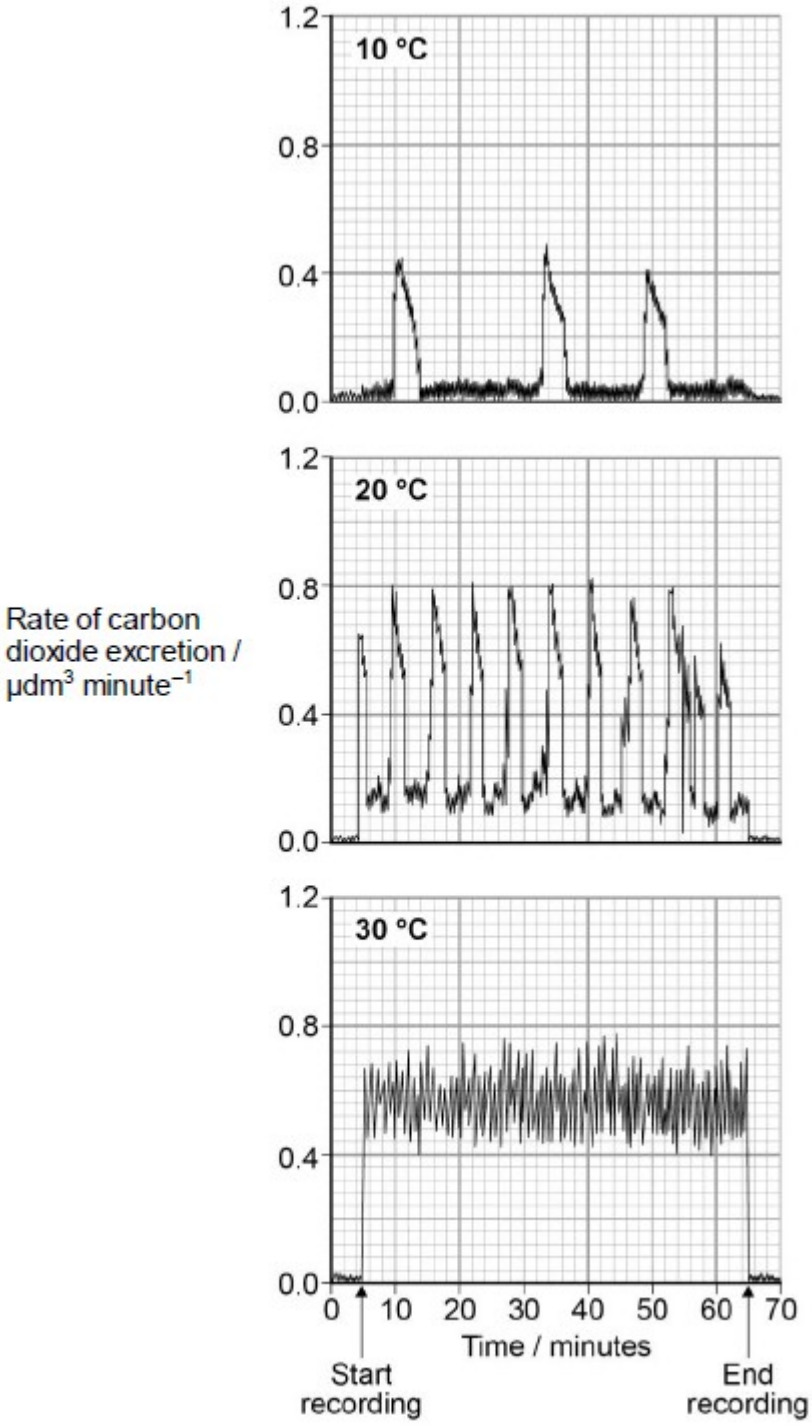
(a) Complete the table above and plot a graph of your calculated values against temperature on the graph paper. Express your calculated rates with the appropriate number of significant figures.



(3)

The body temperature of the insects was largely determined by the temperature they were kept at. At each temperature, the scientists recorded rate of carbon dioxide release by individual insects over time. This rate depends upon spiracles opening or closing.

The graphs below show results for three insects.



(b) Calculate the change in the rate per hour of opening of the spiracles between 10 °C and 20 °C.

_____

_____

(1)

(c) Explain how you could determine the total amount of carbon dioxide secreted at 30 °C during the period of recording.

_____

_____

(1)

(d) Suggest an explanation for the effect of temperature on the rate of carbon dioxide release.

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(3)

(Total 8 marks)

Q8.

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)

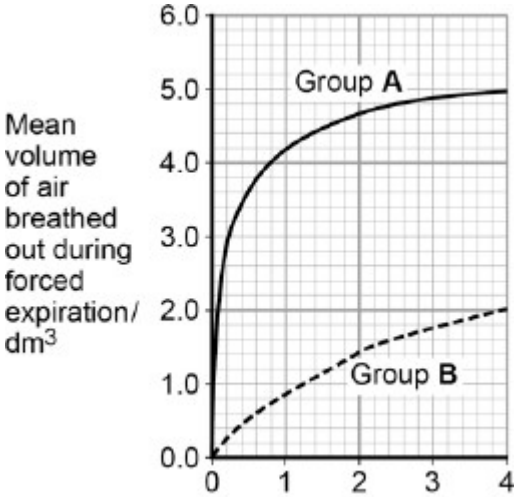
Two groups of people volunteered to take part in an experiment.

- 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 above.

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_____

(4)

(Total 9 marks)

Q9.

(a) Describe how oxygen in the air reaches capillaries surrounding alveoli in the lungs.

Details of breathing are **not** required.

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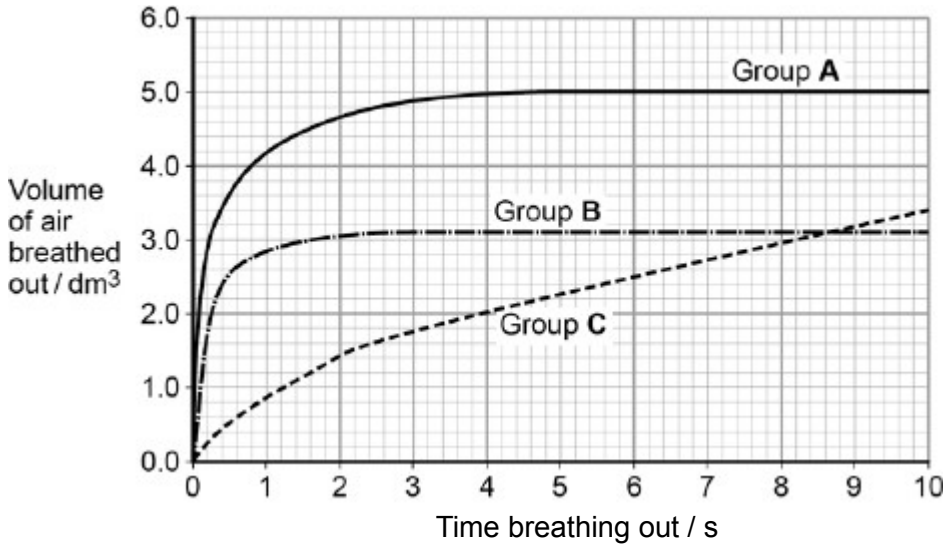
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(4)

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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(3)

(Total 8 marks)

Q10.

A student investigated the distribution of stomata on leaves from two species of plant. She removed small pieces from the lower surface of the leaves of each plant species. She mounted these pieces on separate microscope slides. She then counted the number of stomata in several parts of the epidermis on each piece of leaf tissue using an optical microscope.

(a) Suggest appropriate units the student should use to compare the distribution of stomata on leaves.

_____

(1)

(b) The pieces of leaf tissue examined were very thin.

Explain why this was important.

_____

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_____

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_____

(2)

(c) Give **two** reasons why it was important that the student counted the number of stomata in several parts of each piece of leaf tissue.

1. _____

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2. _____

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(2)

(d) One of the two plant species used by the student in this investigation was a xerophyte.

Other than the distribution of stomata, suggest and explain **two** xerophytic features the leaves of this plant might have.

1. _____

_____

2. _____

_____

(2)

(e) The student then compared the rate of transpiration (evaporation of water) from the two species of plant. She did this by measuring the rate of water uptake by each plant species.

Suggest **two** reasons why the rate of water uptake by a plant might not be the same as the rate of transpiration.

1. _____

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2. _____

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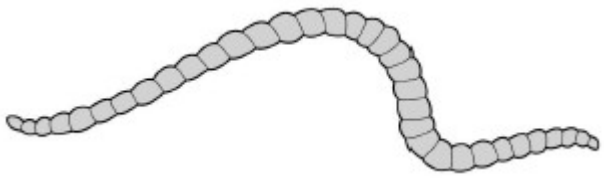
(2)

(Total 9 marks)

Q11.

Tubifex worms are small, thin animals that live in water. They have no specialised gas exchange or circulatory system.

The figure below shows a tubifex worm.



(a) Name the process by which oxygen reaches the cells inside the body of a tubifex worm.

_____

(1)

(b) Using the information provided, explain how **two** features of the body of the tubifex worm allow efficient gas exchange.

1. _____

_____

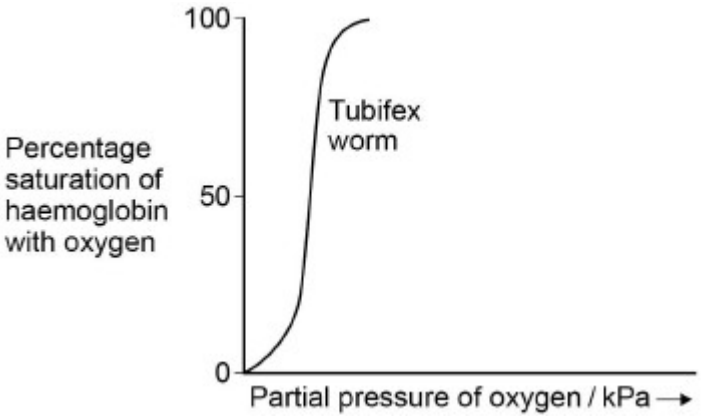
2. _____

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(2)

(c) Most species of tubifex worms live at the bottom of ponds, lakes and rivers where the partial pressure of oxygen is low. Pollution of water by sewage can cause the partial pressure of oxygen to fall below 0.2 kPa.

The graph shows the oxyhaemoglobin dissociation curve for a species of tubifex worm found in a river polluted with sewage.



The species of tubifex worm in the graph has 50% saturation of their haemoglobin with oxygen at 0.08 kPa.

Explain how this enables this species to survive in water polluted with sewage.

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(2)

(d) Species of tubifex worm that live in ponds, lakes and rivers **cannot** survive in seawater.

Use your knowledge of water potential to explain why they cannot survive in seawater.

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(2)

(Total 7 marks)

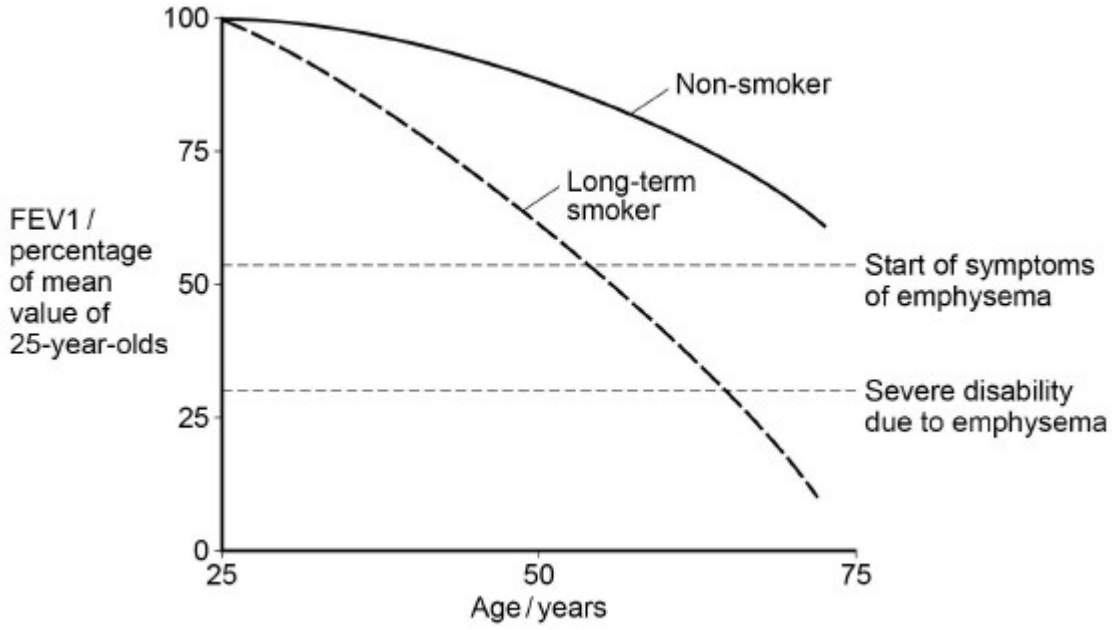
Q12.

Forced expiration volume (FEV1) is the volume of air a person can breathe out in 1 second.

Emphysema is a lung disease which results in a reduction in FEV1. Emphysema is mainly caused by long-term cigarette smoking.

Scientists investigated the effects of ageing and long-term cigarette smoking on FEV1 and on the development of emphysema.

The graph shows their results.



(a) Scientists determined the mean FEV1 value of 25-year-olds in the population.

Suggest **two** precautions that should have been taken to ensure that this mean FEV1 value was reliable.

1. _____

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_____

2. _____

_____

_____

(2)

(b) Explain the importance of determining a mean FEV1 value of 25-year-olds in this investigation.

_____

_____

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_____

(2)

(c) The mean FEV1 value of non-smokers decreases after the age of 30.

Use your knowledge of ventilation to suggest why.

_____

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(1)

(d) One of the severe disabilities that results from emphysema is that walking upstairs becomes difficult.

Explain how a low FEV1 value could cause this disability.

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(3)

(Total 8 marks)

Q13.

(a) Explain the role of the diaphragm in breathing out.

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(3)

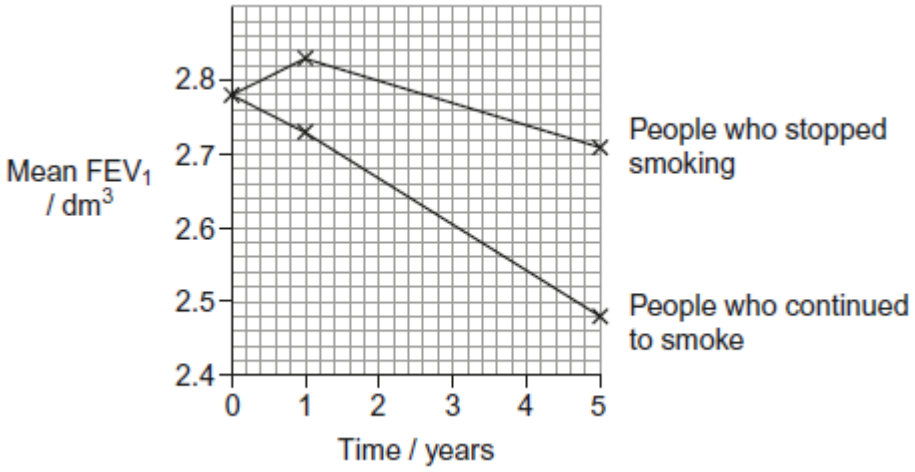
Scientists investigated the effect of stopping smoking on the forced expiratory volume of people. The forced expiratory volume (FEV_1) is the greatest volume of air that a person can breathe out in 1 second.

The scientists recruited a large number of people who smoked. Some of these smokers stopped smoking at the start of the investigation whilst others continued to smoke.

The scientists:

- measured the FEV_1 of each person and calculated the mean FEV_1
- re-measured the FEV_1 of each person after one year and calculated the mean FEV_1 of the smokers and the mean FEV_1 of the people who had stopped smoking
- repeated this at the end of five years.

The graph shows the scientists' results.



(b) Use the data shown in the graph to compare the change in FEV_1 of people who continued to smoke with those who stopped smoking.

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(2)

(c) Smoking causes changes in the lungs and airways of smokers.
Suggest two changes in the lungs of people who continue to smoke that could explain the change in their FEV_1.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)

Q14.

(a) (i) Name the structure through which gases enter and leave the body of an insect.

_____

(1)

(ii) Name the small tubes that carry gases directly to and from the cells of an insect.

_____

(1)

(b) Explain the movement of oxygen into the gas exchange system of an insect when it is at rest.

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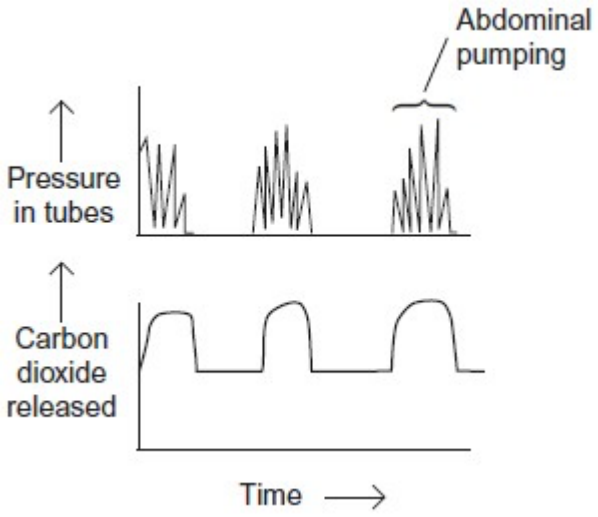
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(3)

(c) Abdominal pumping takes place during vigorous activity in insects. This causes regular squeezing of the tubes of the gas exchange system.

A scientist investigated the effect of abdominal pumping on the pressure in the tubes and the volume of carbon dioxide released by the insect.

Her results are shown below.



Describe and explain these results.

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(3)

(Total 8 marks)

Q15.

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?

_____

_____

(1)

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

_____

_____

_____

_____

_____

_____

(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 _____

_____

_____

(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 _____

_____

Feature 2 _____

Explanation _____

_____

(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.

_____

_____

_____

(1)

(Total 8 marks)

Q16.

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:

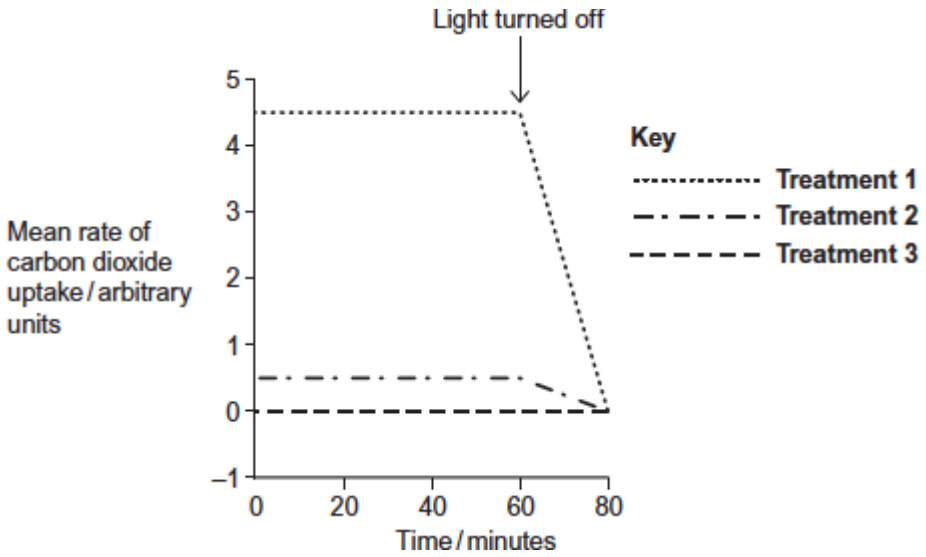
Treatment 1 − No air-sealing grease was applied to either surface of the leaf.

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

_____

_____

Treatment 2

Treatment 3

(3)

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

(2)

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

Explain the advantage of this to the plant.

(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.

(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.

_____

_____

_____

_____

_____

(2)

(Total 10 marks)

Q17.

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 types of air / breaths per minute	**Grasshopper 1**	53	11	99	107
	Grasshopper 2	48	25	88	99
	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. _____

_____

2. _____

_____

(2)

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

_____

_____

_____

_____

_____

_____

(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. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

(3)

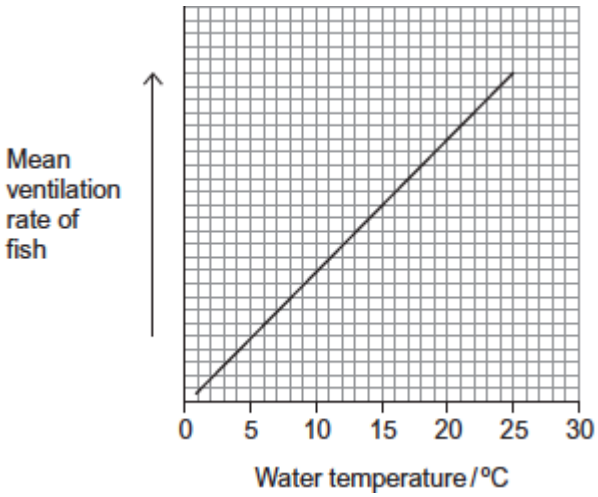
(Total 10 marks)

Q18.

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.

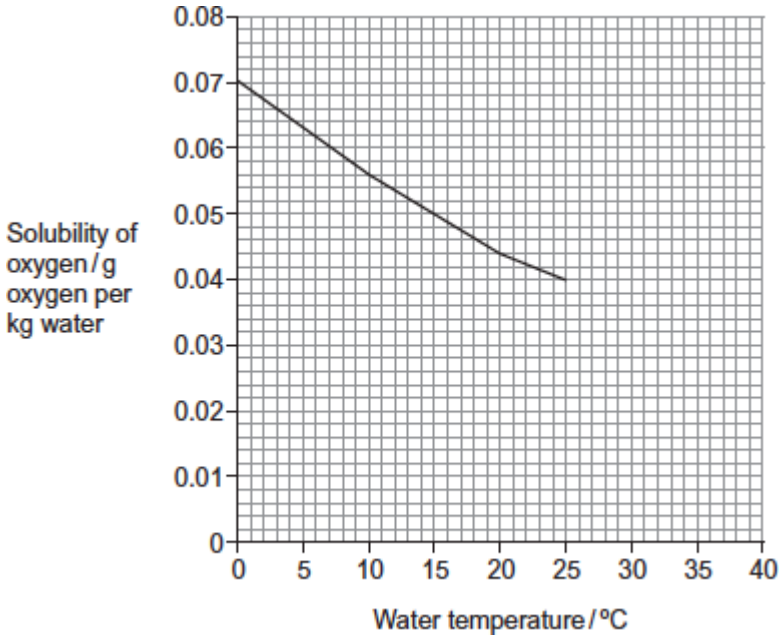
Her results are shown in **Figure 1**.

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.

_____

_____

(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.

_____

_____

_____

(1)

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

_____

_____

_____

(1)

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

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q19.

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

_____

_____

_____

_____

_____

_____

(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. _____

_____

2. _____

_____

(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.

_____

_____

_____

(1)

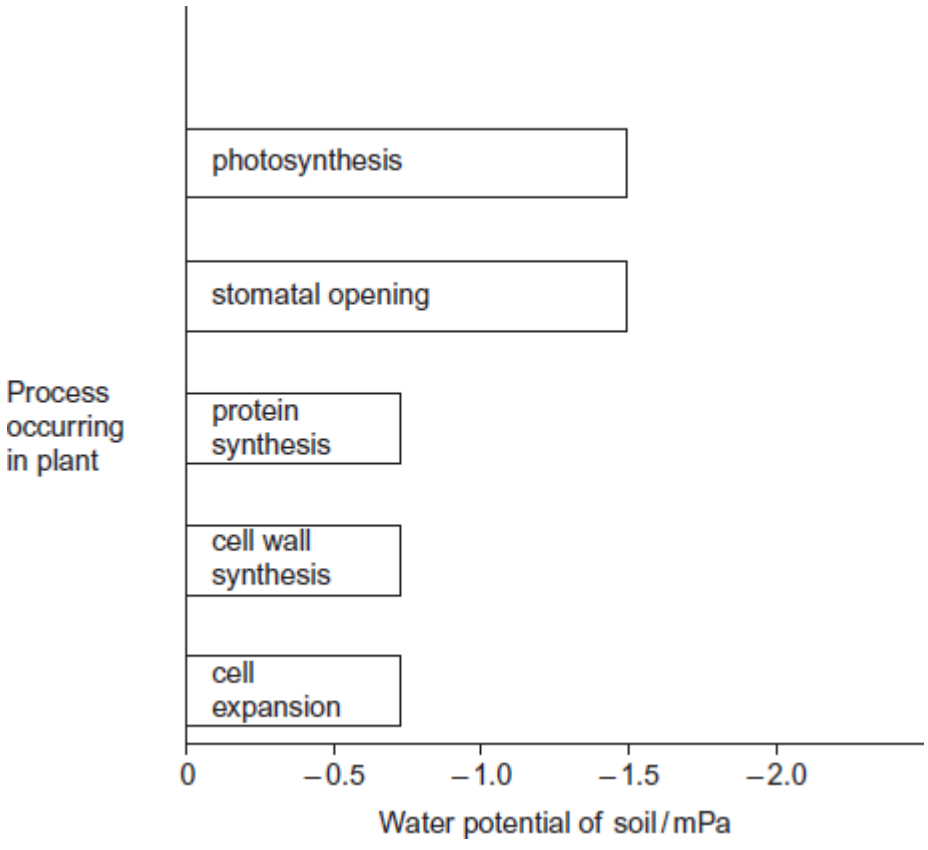
(Total 8 marks)

Q20.

Scientists investigated the effect of the water potential of soil water on plant growth. They investigated the effect of this water potential on several plant processes.

The figure below shows their results in the form they were presented. The bars show whether or not each process was occurring.

The plants stopped growing when the water potential of the soil water was below –0.7 mPa. All of the changes in the plants were related to the ability of the roots to take up water from the soil.



(a) Describe the results in the figure.

_____

_____

_____

_____

_____

(2)

(b) Explain the relationship between stomatal opening and photosynthesis.

_____

_____

_____

_____

_____

(2)

(c) Although photosynthesis is still occurring, plants stop growing when the soil water potential falls below –0.7 mPa.

Use information from the figure above to suggest two reasons why.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q21.

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

_____

(1)

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

1. _____

_____

2. _____

_____

(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.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q22.

Large insects contract muscles associated with the abdomen to force air in and out of the spiracles. This is known as 'abdominal pumping'. The table shows the mean rate of abdominal pumping of an insect before and during flight.

Stage of flight	**Mean rate of abdominal pumping/dm^3 of air kg^{-1} hour^{-1}**
Before	42
During	186

(a) Calculate the percentage increase in the rate of abdominal pumping before and during flight. Show your working.

Answer _____ %

(2)

(b) Abdominal pumping increases the efficiency of gas exchange between the tracheoles and muscle tissue of the insect. Explain why.

_____

_____

_____

_____

_____

(2)

(c) Abdominal pumping is an adaptation not found in many small insects. These small insects obtain sufficient oxygen by diffusion.

Explain how their small size enables gas exchange to be efficient without the need for abdominal pumping.

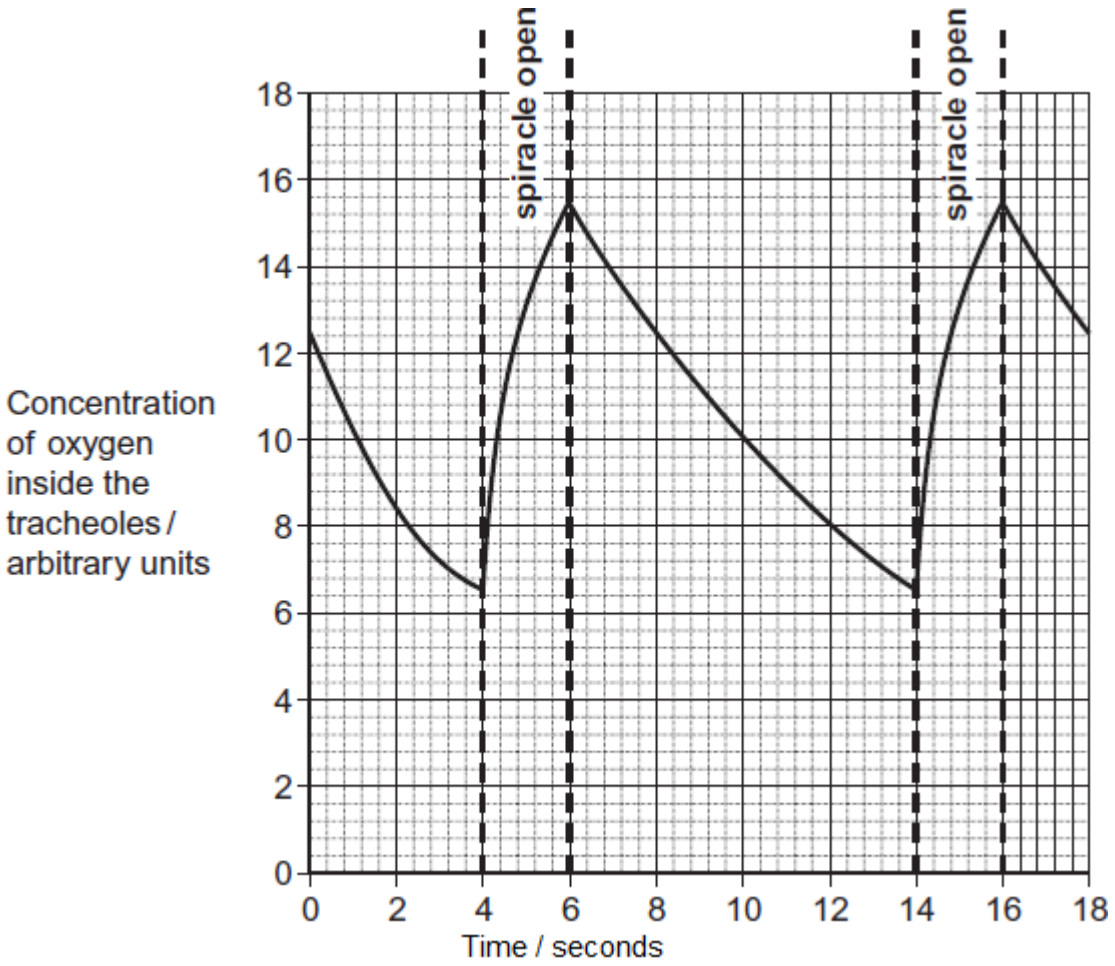
_____

_____

_____

(1)

The graph shows the concentration of oxygen inside the tracheoles of an insect when at rest. It also shows when the spiracles are fully open.



(d) Use the graph to calculate the frequency of spiracle opening. Show your working.

Frequency _____ times per minute

(2)

(e) The insect opens its spiracles at a lower frequency in very dry conditions. Suggest **one** advantage of this.

_____

_____

_____

(1)

(f) The ends of tracheoles connect directly with the insect's muscle tissue and are filled with water. When flying, water is absorbed into the muscle tissue. Removal of water from the tracheoles increases the rate of diffusion of oxygen between the tracheoles

and muscle tissue. Suggest **one** reason why.

_____

_____

_____

(1)

(Total 9 marks)

Q23.

Doctors investigated the effect of the smoking habits of men on their non-smoking wives.

The doctors recruited 540 non-smoking women aged 40 or older. They divided these women into groups according to the smoking habits of their husbands.
After 14 years, the doctors recorded how many of the wives had died and their cause of death.

They used these data to determine the relative risk of a wife dying from a particular disease according to her husband's smoking habit.

In this comparison, they gave the relative risk to the wife of a non-smoker as 1.00. A value greater than 1.00 shows an increased risk compared to the wife of a non-smoker.

The results are shown in the table below.

Cause of death	**Relative risk of wife dying**		
	Husband non-smoker	**Husband smokes 1 to 19 cigarettes /day**	**Husband smokes more than 19 cigarettes / day**
Lung cancer	1.00	1.61	2.08
Emphysema	1.00	1.29	1.49
Cervical cancer	1.00	1.15	1.14
Stomach cancer	1.00	1.02	0.99
Heart disease	1.00	0.97	1.03

A journalist concluded from these data that if a husband smoked, it greatly increased the risk of his wife dying of certain diseases. Evaluate this statement.

_____

_____

_____

_____

_____

_____

_____

_____

(Total 4 marks)

Q24.

Scientists used fossil leaves from one species of pine tree to investigate whether changes in the concentration of carbon dioxide in the air over long periods of time had led to changes in the number of stomata in the leaves.

Their method is outlined below.

- They selected sites of different ages.
- They collected between 11 and 24 fossil leaves from each site.
- They found the mean number of stomata per mm^2 on the leaves from each site.
- They estimated the age of each sample by dating organic remains around the leaves at each site.

They compared results from the fossil leaves with leaves from the same species of pine tree growing today.

They knew the concentration of carbon dioxide in the air at different times in the past.

Their results are shown in the table.

Age of sample/years	Concentration of carbon dioxide in the air/%	Mean number of stomata per mm^2 (± standard deviation)
present day	0.0350	92 (±2)
5000	0.0270	87 (±4)
10 000	0.0250	95 (±2)
15 000	0.0205	108 (±6)
20 000	0.0195	115 (±4)
25 000	0.0188	118 (±6)
30 000	0.0190	130 (±6)

(a) The concentration of carbon dioxide in the air has changed with time. Use the data to describe how.

_____

_____

_____

_____

_____

(2)

(b) The scientists calculated the mean number of stomata per mm^2 and the standard deviation.

What does the standard deviation show?

_____

_____

_____

_____

_____

(2)

(c) The scientists found the age of the fossil leaves by dating the organic remains around them.
Would this have affected the accuracy of their data? Explain your answer.

_____

_____

_____

(1)

(d) 30 000 years ago the mean number of stomata per mm^2 on the lower epidermis of pine tree leaves was much higher than it is today. This would have enabled the plant to grow faster when the carbon dioxide concentration of the air was low.

Explain why.

_____

_____

_____

(1)

(e) A student who saw these results concluded that as the carbon dioxide concentration of the air had increased the number of stomata per mm^2 in leaves had decreased.
Do the results support this conclusion?

_____

_____

_____

_____

_____

_____

(3)

(f) The leaves of plants that grow in dry areas usually have a low number of stomata per mm^2. Use your knowledge of leaf structure to suggest **three** other adaptations that the leaves might have that enable the plants to grow well in dry conditions.

1. _____

2. _____

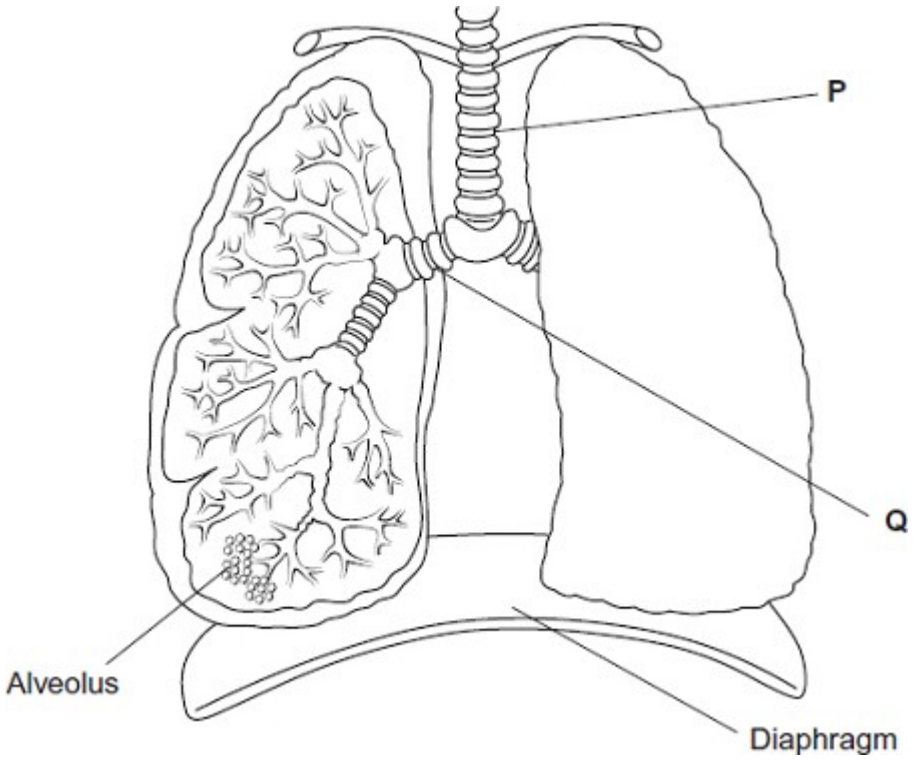
3. _____

(3)

(Total 12 marks)

Q25.

(a) The diagram shows the structure of the human gas exchange system.



Name organs

P _____

Q _____

(1)

(b) Explain how downward movement of the diaphragm leads to air entering the lungs.

_____

_____

_____

_____

(2)

(Total 3 marks)

Q26.

The ‘placebo effect’ describes the improvement in patients’ symptoms due to psychological effects. Scientists investigated the placebo effect in patients with asthma. They divided a large number of asthma patients into three groups, **1**, **2** and **3**.

- Group 1 inhaled a spray containing albuterol every day. Albuterol is a drug used to treat asthma.
- Group 2 inhaled a placebo spray every day. This was identical to the spray given to group 1 but it did not contain albuterol.
- Group 3 did not receive any spray treatment.

(a) Describe one way the scientists could have allocated the patients to each group.

_____

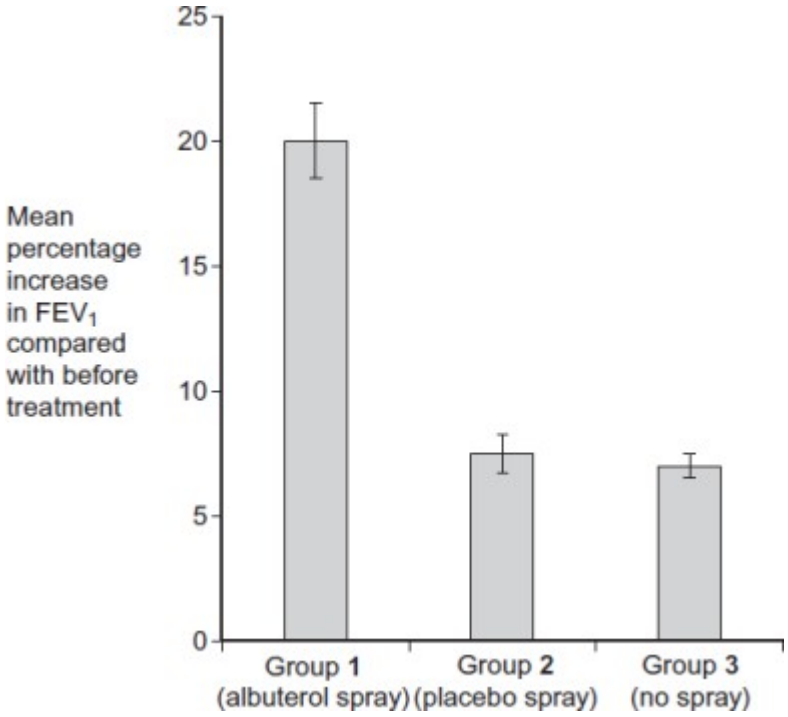
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_____

_____

(2)

The scientists measured the forced expiratory volume (FEV_1) of each patient at regular intervals. The forced expiratory volume (FEV_1) is the volume of air forced out of the lungs in the first second when breathing out. The scientists recorded each patient’s FEV_1 before treatment started and after 60 days of treatment. They then calculated the mean increase in FEV_1 for each group. Their results are shown in the graph. The bars show the standard deviation.



(b) What do the standard deviation bars suggest about the difference in the mean increase in FEV_1 between Group **1** and the other groups? Explain your answer.

_____

_____

_____

_____

_____

(2)

(c) What do the data suggest about the 'placebo effect' in this investigation? Explain your answer.

_____

_____

_____

_____

_____

(2)

(d) On each occasion that a patient's FEV_1 was measured, a doctor repeated the measurement several times. Explain why.

_____

_____

_____

_____

_____

(2)

(e) All the patients continued with their normal treatment for asthma. The normal treatment was the same for all patients and its effects were short-lived. The patients were told to stop this treatment 24 hours before FEV_1 measurements were taken.

(i) Suggest why all the patients were allowed to continue with their normal asthma treatment in this investigation.

_____

_____

_____

(1)

(ii) Suggest why the patients were told to stop their normal asthma treatment 24 hours before their FEV_1 measurements were taken.

_____

_____

_____

_____

_____

_____

(2)

(f) After 60 days, the patients in each group were asked to give themselves an *Improvement* Score from 0-10 to show how much they felt their symptoms had improved. This was done before their FEV_1 was measured. The scientists calculated the mean *Improvement* Score for each group.

(i) The scientists concluded that the data obtained for the Improvement Scores were less reliable than the data obtained measuring FEV_1. Suggest why they concluded this.

_____

_____

_____

_____

_____

_____

(2)

(ii) Group 3 reported the lowest mean *Improvement* Score. Suggest **one** explanation for this.

_____

_____

_____

_____

_____

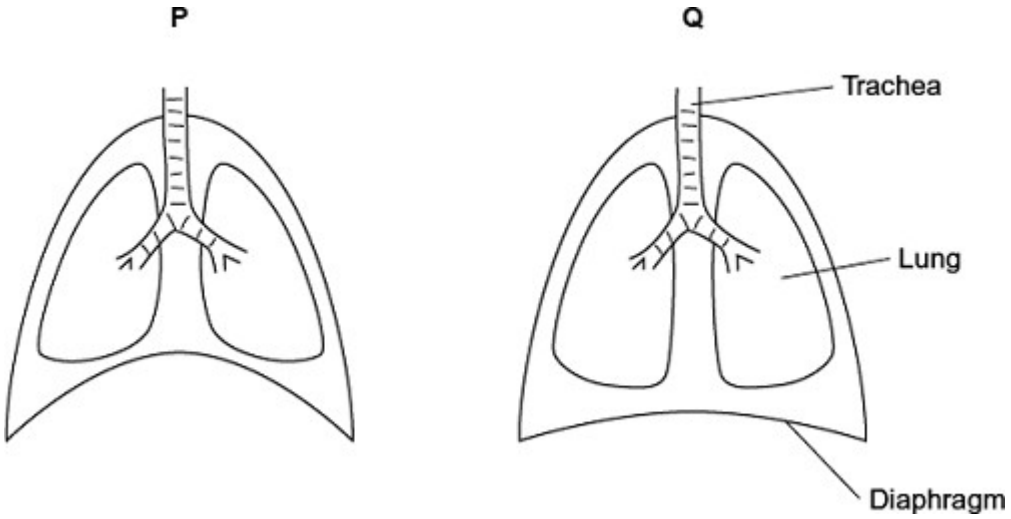
_____

(2)

(Total 15 marks)

Q27.

The diagram shows the position of the diaphragm at times **P** and **Q**.



(a) Describe what happens to the diaphragm between times **P** and **Q** to bring about the change in its shape.

_____

_____

_____

_____

_____

(2)

(b) Air moves into the lungs between times **P** and **Q**. Explain how the diaphragm causes this.

_____

_____

_____

_____

_____

(3)

(c) Describe how oxygen in air in the alveoli enters the blood in capillaries.

_____

_____

_____

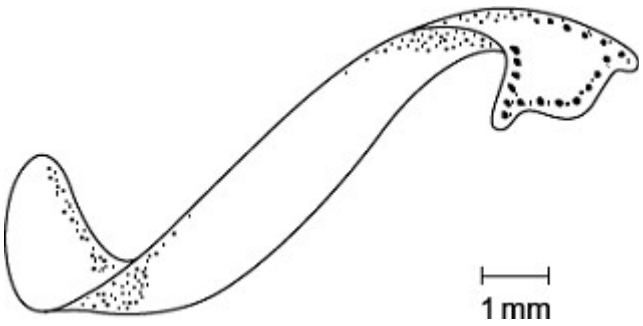
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(2)

(Total 7 marks)

Q28.

(a) Flatworms are small animals that live in water. They have no specialised gas exchange or circulatory systems.
The drawing shows one type of flatworm.



(i) Name the process by which oxygen reaches the cells inside the body of this flatworm.

_____

(1)

(ii) The body of a flatworm is adapted for efficient gas exchange between the water and the cells inside the body.
Using the diagram, explain how **two** features of the flatworm's body allow efficient gas exchange.

1. _____

_____

2. _____

_____

(2)

(b) (i) A leaf is an organ. What is an organ?

_____

_____

_____

(1)

(ii) Describe how carbon dioxide in the air outside a leaf reaches mesophyll cells inside the leaf.

_____

_____

_____

_____

_____

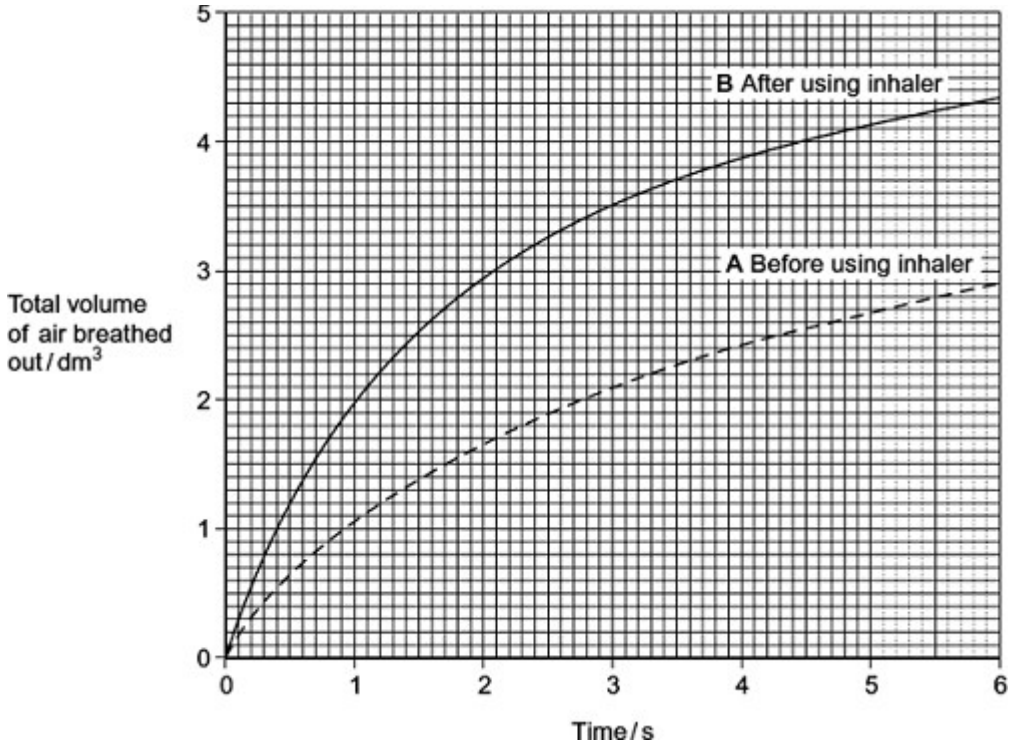
_____

(3)

(Total 7 marks)

Q29.

A person with asthma breathed out as hard as he could. The graph shows the volume of air he breathed out in the first 6 seconds of a breath. Curve **A** shows the volume before he used an inhaler. Curve **B** shows the volume after he used an inhaler.



(a) The diaphragm helps to bring about the changes shown by the curve **A**.
Explain how.

_____

_____

_____

_____

_____

(3)

(b) You could use curve **A** to find the total volume of air that this person could breathe out in one complete breath. Describe how.

_____

_____

_____

_____

_____

(2)

(c) The inhaler which the person used contained a substance that dilates bronchioles.
Use this information to explain why curve **A** is different from curve **B**.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q30.

(a) Scientists who investigate disease may look at risk factors. What is a risk factor?

_____

_____

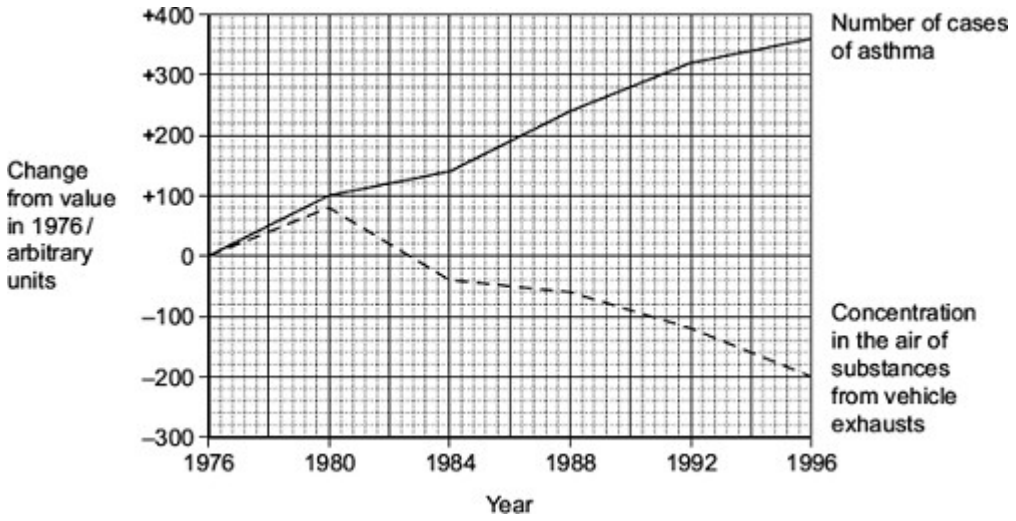
_____

(1)

Scientists investigated the link between pollution from vehicle exhausts and the number of cases of asthma. Between 1976 and 1996, the scientists recorded changes in the following

- the concentration in the air of substances from vehicle exhausts
- the number of cases of asthma.

The graph shows their results



(b) Between which years on the graph was there

(i) a positive correlation between the number of cases of asthma and the concentration in the air of substances from vehicle exhausts

_____

(1)

(ii) a negative correlation between the number of cases of asthma and the concentration in the air of substances from vehicle exhausts?

_____

(1)

(c) The scientists concluded that substances in the air from vehicle exhausts did not cause the increase in asthma between 1976 and 1980. Explain why.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q31.

(a) Explain how oxygen is loaded, transported and unloaded in the blood.

(6)

Midges are very small insects. The early stages of the life cycle of midges are called larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

Concentration of oxygen in water /cm^3 dm^{-3}	**Mean rate of oxygen uptake / cm^3 g^{-1} h^{-1}**	
	Chironomus longistylus	*Tanytarsus brunnipes*
1	220	141
2	285	246
3	304	342
4	313	362
5	320	367
6	318	430
7	320	469

(b) The larvae in this investigation were kept at a temperature of 17 °C. Why was it important that the larvae of both species were kept at the same temperature?

_____

_____

(2)

(c) Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

_____

_____

_____

_____

_____

(2)

(d) *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table in part (a) to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

_____

_____

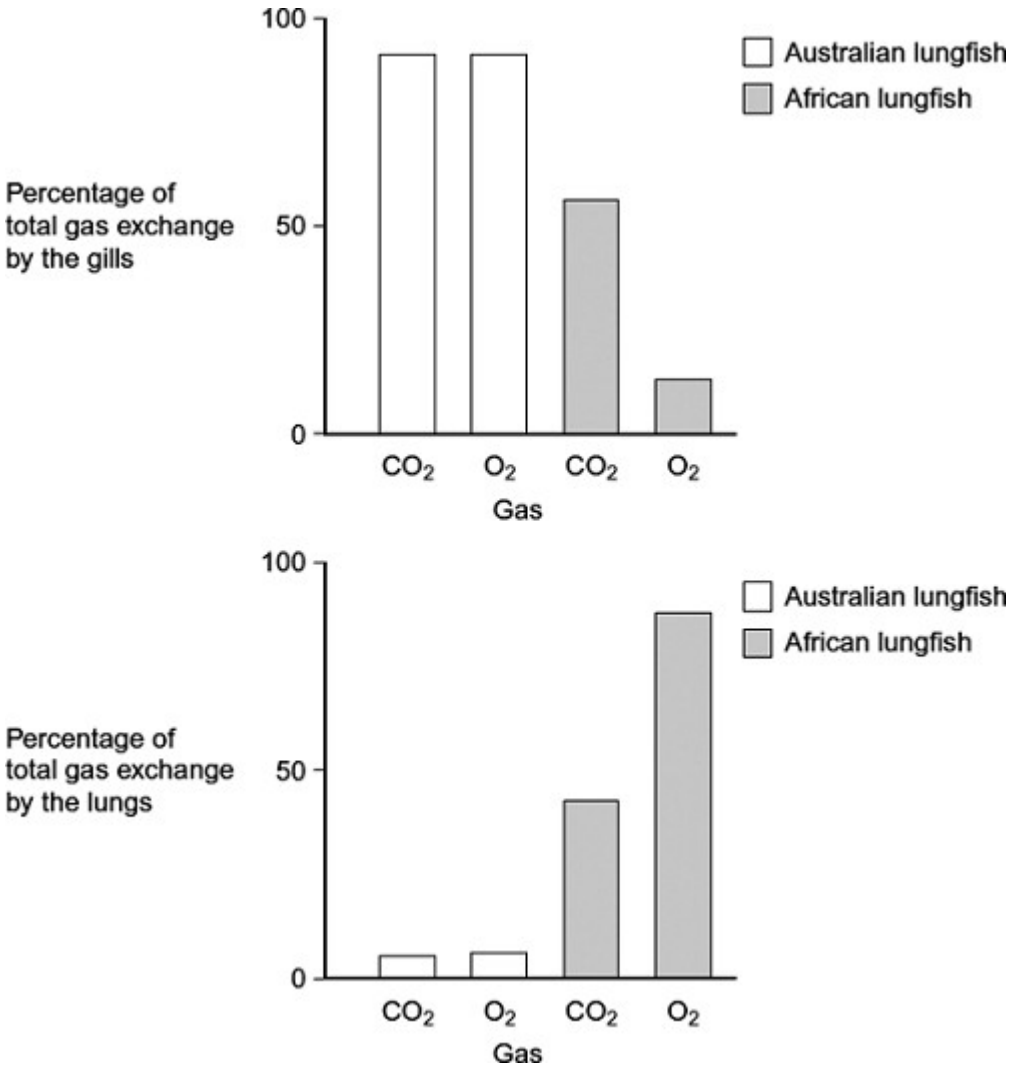
_____

_____

_____

(2)

(e) Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.



(i) Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

_____

_____

_____

(1)

(ii) African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

_____

_____

_____

_____

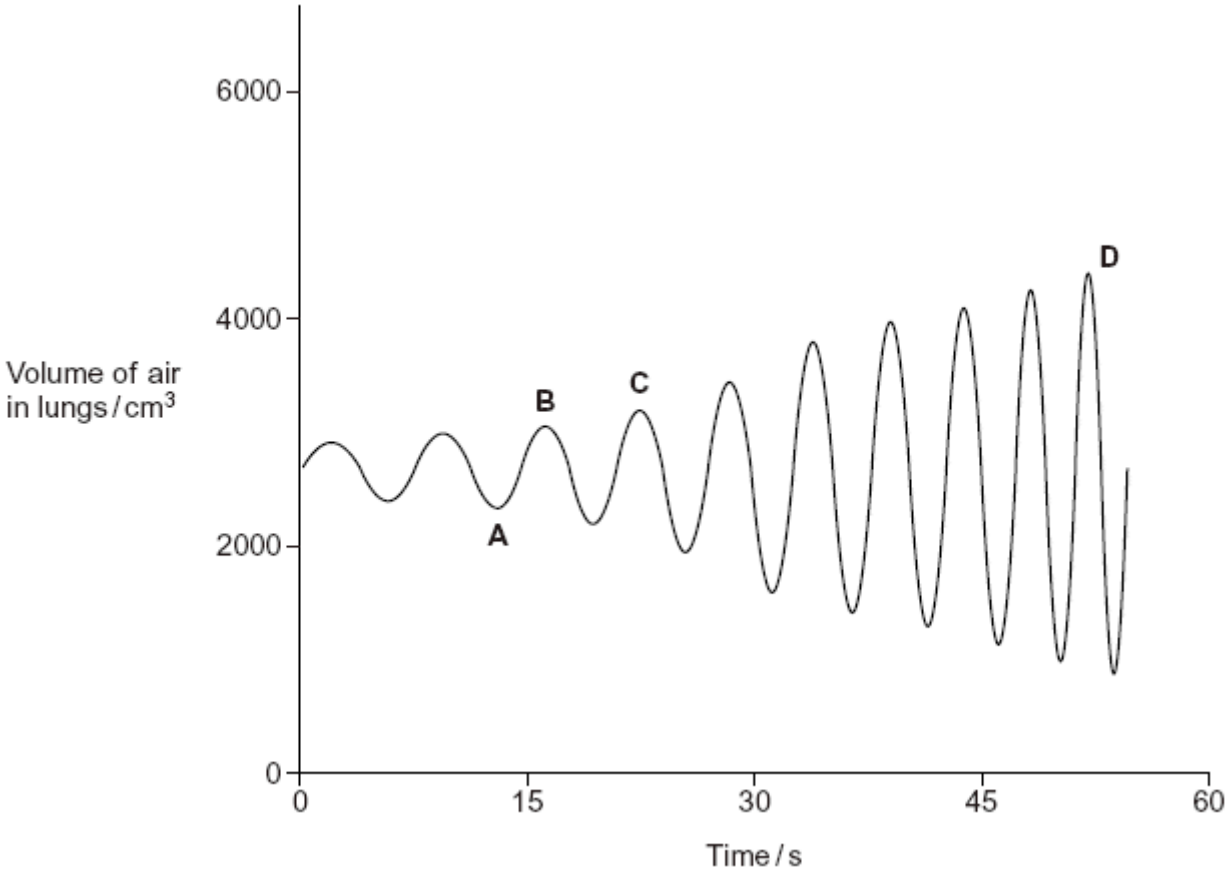
_____

(2)

(Total 15 marks)

Q32.

The graph shows changes in the volume of air in a person's lungs during breathing.



The person was breathing in between times **A** and **B** on the graph.

(i) Explain how the graph shows that the person was breathing in between times **A** and **B**.

_____

_____

(1)

(ii) Describe and explain what happens to the shape of the diaphragm between times **A** and **B**.

_____

_____

_____

_____

(2)

(Total 3 marks)

Q33.

(a) Many different substances enter and leave a cell by crossing its cell surface

membrane. Describe how substances can cross a cell surface membrane.

(5)

(b) Describe and explain how the lungs are adapted to allow rapid exchange of oxygen between air in the alveoli and blood in the capillaries around them.

(5)

(Total 10 marks)

Q34.

Miner's lung is a disease caused by breathing in dust in coal mines. The dust causes the alveolar epithelium to become thicker. People with miner's lung have a lower concentration of oxygen in their blood than healthy people.

(a) (i) Describe the path by which oxygen goes from an alveolus to the blood.

_____

_____

_____

_____

(2)

(ii) Explain why people with miner's lung have a lower concentration of oxygen in their blood.

_____

_____

(1)

(b) In healthy lungs, a gradient is maintained between the concentration of oxygen in the alveoli and the concentration of oxygen in the lung capillaries.

(i) Describe how ventilation helps to maintain this difference in oxygen concentration.

_____

_____

_____

_____

_____

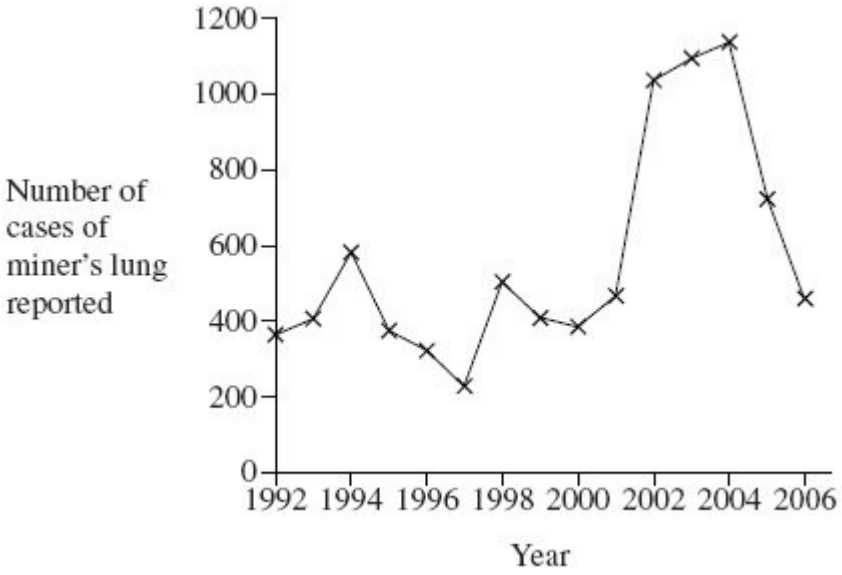
(2)

(ii) Give **one** other way that helps to maintain the difference in oxygen concentration.

_____

(1)

(c) Scientists investigated the number of cases of miner's lung reported in Britain between 1992 and 2006.



Coal mining in Britain had been dramatically reduced by 1990.

Some scientists concluded that the rise in reported cases of miner's lung after 1992 shows that the disease takes a long time to develop.

Evaluate this conclusion.

_____

_____

_____

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(2)

(Total 8 marks)

Q35.

(a) Gas exchange in fish takes place in gills. Explain how **two** features of gills allow efficient gas exchange.

1. _____

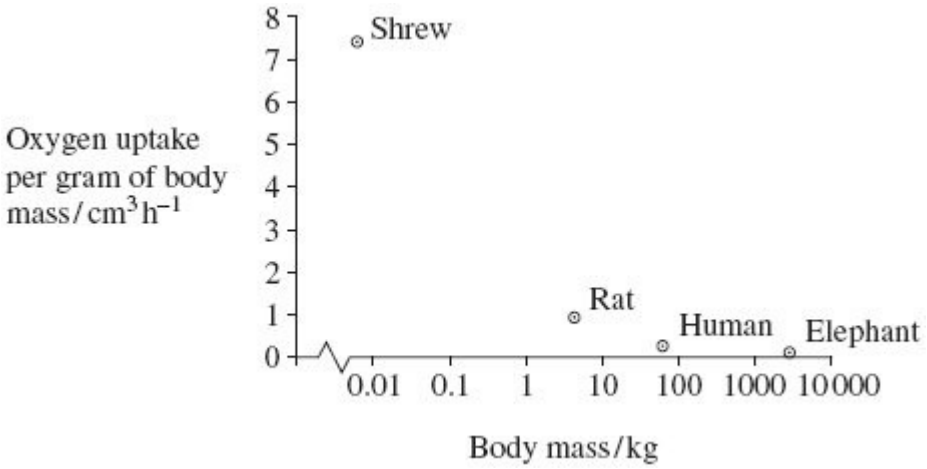
_____

2. _____

_____

(2)

(b) A zoologist investigated the relationship between body mass and rate of oxygen uptake in four species of mammal. The results are shown in the graph.



(i) The scale for plotting body mass is a logarithmic scale. Explain why a logarithmic scale was used to plot body mass.

_____

_____

(1)

(ii) Describe the relationship between body mass and oxygen uptake.

_____

_____

(1)

(iii) The zoologist measured oxygen uptake per gram of body mass. Explain why he measured oxygen uptake per gram of body mass.

_____

_____

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(2)

(Total 6 marks)

Q36.

Read the following passage.

Several diseases are caused by inhaling asbestos fibres. Most of these diseases result from the build up of these tiny asbestos fibres in the lungs.

One of these diseases is asbestosis. The asbestos fibres are very small and enter the bronchioles and alveoli. They cause the destruction of phagocytes and the surrounding lung tissue becomes scarred and fibrous. The fibrous tissue reduces the elasticity of the lungs and causes the alveolar walls to thicken. One of the main symptoms of asbestosis is shortness of breath caused by reduced gas exchange.

People with asbestosis are at a greater risk of developing lung cancer. The time between exposure to asbestos and the occurrence of lung cancer is 20–30 years.

Use information in the passage and your own knowledge to answer the following questions.

(a) Destruction of phagocytes (lines 4–5) causes the lungs to be more susceptible to infections. Explain why.

_____

_____

_____

_____

(2)

(b) (i) The reduced elasticity of the lungs (lines 6–7) causes breathing difficulty. Explain how.

_____

_____

_____

_____

(2)

(ii) Apart from reduced elasticity, explain how changes to the lung tissue reduce the efficiency of gas exchange.

_____

_____

_____

_____

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_____

(4)

(c) (i) Doctors did not make the link between exposure to asbestos and an increased risk of developing lung cancer for many years. Use information in the passage to explain why.

_____

_____

(1)

(ii) Give **one** factor, other than asbestos, which increases the risk of developing lung cancer.

_____

(1)

(Total 10 marks)

Q37.

(a) A fish uses its gills to absorb oxygen from water. Explain how the gills of a fish are adapted for efficient gas exchange.

_____

_____

_____

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(6)

Mackerel live in the surface waters of the sea. Toadfish live on the seabed in deep water.

(b) The concentration of oxygen is higher in the surface waters than it is in water close to the seabed. Suggest why.

_____

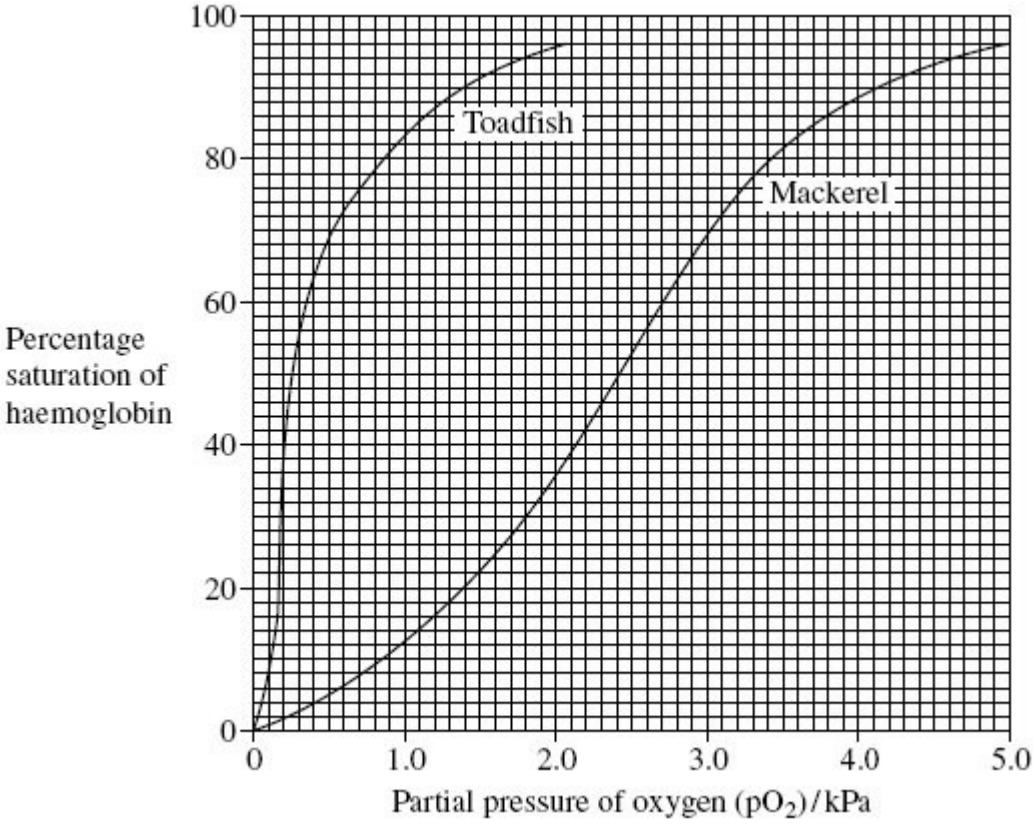
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_____

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(2)

(c) The graph shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

_____

_____

_____

_____

(2)

(d) Scientists analysed the sequence of amino acids in one polypeptide chain in the haemoglobin of four different species of ape. The only difference they found affected the amino acids at three positions in the polypeptide chain. Their results are shown in the table. The letters are abbreviations for particular amino acids.

Species	Position 87	Position 104	Position 125
Chimpanzee	T	R	P
Bonobo	T	R	P
Gorilla	T	K	P
Orang utan	K	R	Q

What information do the data in the table suggest about the relationships between the chimpanzee, the bonobo and the gorilla? Explain your answer.

_____

_____

_____

_____

(2)

(Total 12 marks)

Q38.

Read the following passage.

Campylobacter jejuni is a bacterium. It is one of the commonest causes of diarrhoea in humans. The illness that it causes does not usually last very long and many sufferers do not even go to the doctor. The only treatment required is the use of oral rehydration solutions to replace the water lost by diarrhoea. In 1998, laboratory tests confirmed 60 000 cases of diarrhoea caused by this bacterium in the UK. The bacterium was more frequently found in males than in females with a ratio of 1.5 : 1.

In rare cases, the nervous system may be affected. Scientists are now beginning to understand the cause of this. Sugars in the antigens on the surface of the bacteria are identical to some of the sugars on the surface of nerve cells. Antibodies produced against the bacteria may therefore attack the body's nerve cells. There can be serious problems if this leads to paralysis of the diaphragm. Breathing difficulties result and the patient may die.

Use information in the passage and your own knowledge to answer the following questions.

(a) (i) The number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in the UK in 1998 was 60 000 (lines 4–5). Explain why the true number of cases is thought to be more than this.

_____

_____

_____

(1)

(ii) Calculate the number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in men in 1998.

Answer _____

(1)

(b) Explain why antibodies produced against *Campylobacter jejuni* also attack nerve cells (lines 9 –10).

_____

_____

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(3)

(c) Explain how paralysis of the diaphragm leads to breathing difficulties (line 11).

_____

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(2)

(Total 7 marks)

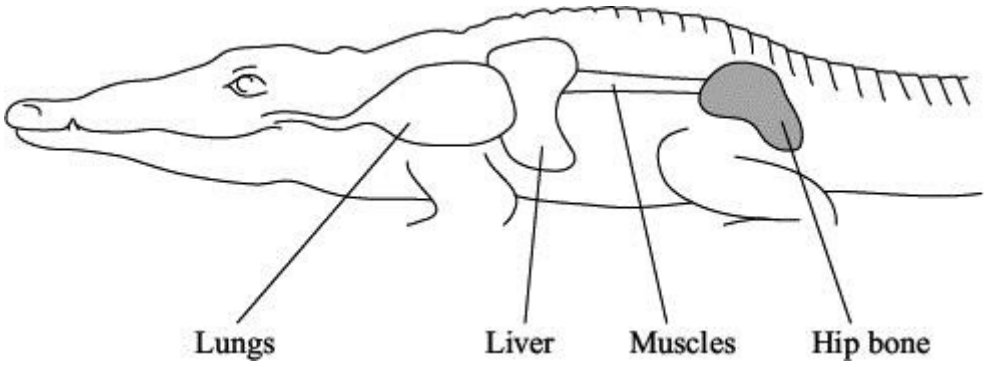
Q39.

Read the following passage.

When a person breathes in, the diaphragm muscle contracts and the diaphragm flattens. This, together with movement of the ribs, leads to air being drawn into the lungs. Breathing out is generally passive and results from the relaxation of the diaphragm muscle and the elastic recoil of the lung tissue.

Two sets of intercostal muscles also play an important part in breathing in humans. Contraction of the external intercostal muscles is associated with breathing in. During strenuous exercise, contraction of the internal intercostal muscles helps force air out of the lungs. In this case, breathing out is active.

Crocodiles also have lungs and breathe air. They have well developed intercostal muscles but do not appear to use these during breathing. They also lack a diaphragm. Breathing in, in crocodiles, is brought about by contraction of muscles attaching the liver to the hip bones (see diagram). This pulls the liver back and causes air to enter the lungs. Breathing out results from the contraction of abdominal muscles which move the liver forwards.



Use information in the passage and your own knowledge to answer the questions.

(a) Describe the movement of the ribs when a person breathes in (line 2).

_____

_____

(1)

(b) (i) Explain what is meant by passive (line 3).

_____

_____

(1)

(ii) Is breathing out in crocodiles active or passive? Explain your answer.

_____

_____

(1)

(c) Explain how movement of the liver causes air to enter a crocodile's lungs.

_____

_____

_____

_____

_____

_____

(3)

(d) Describe the difference in the composition of gases in inhaled and exhaled air. Explain how these differences are caused.

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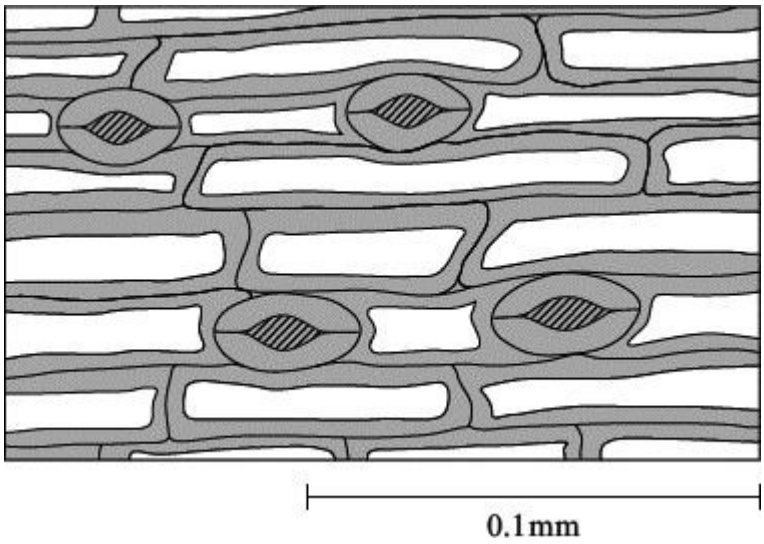
_____

(6)

(Total 12 marks)

Q40.

The drawing shows part of the lower leaf epidermis of sorghum.



(a) Calculate the number of stomata per mm^2 of the leaf surface. Show your working.

Answer _____ stomata per mm^2

(2)

(b) Sorghum has few stomata per mm^2 of leaf surface area. Explain how this is an adaptation to the conditions in which sorghum grows.

_____

_____

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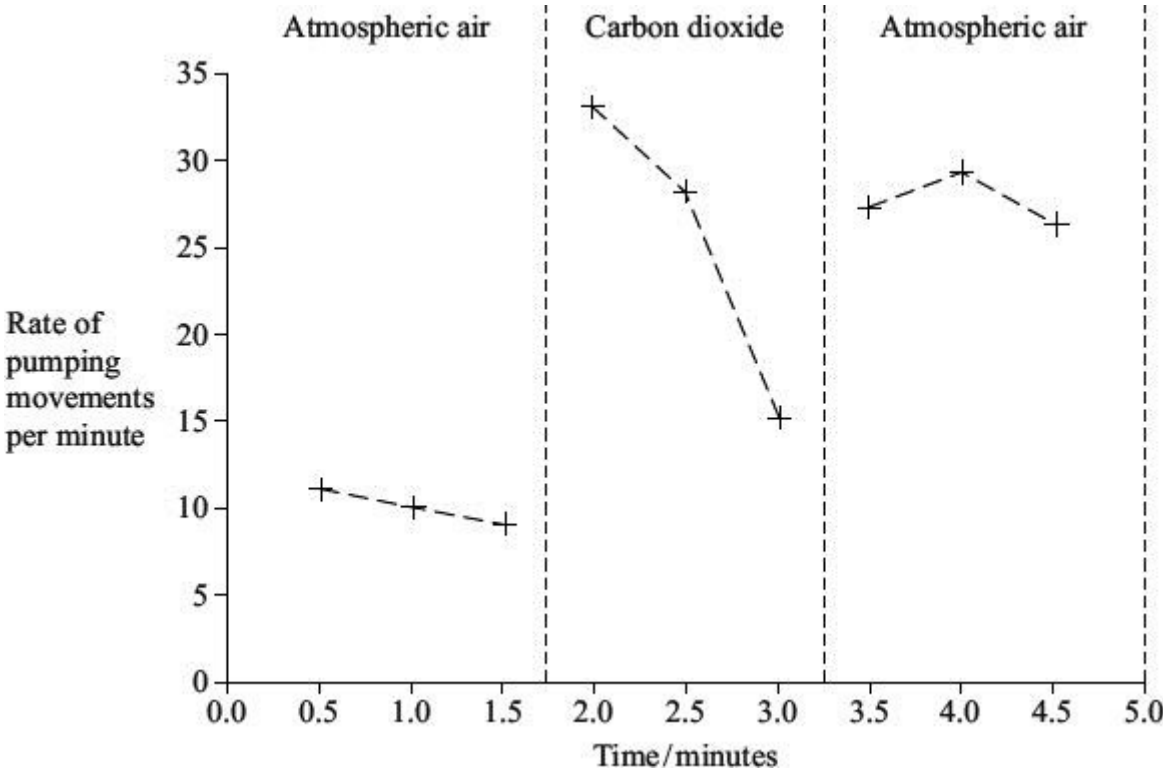
(3)

(Total 5 marks)

Q41.

In an investigation, a locust was given alternating supplies of atmospheric air and pure carbon dioxide. The rate of pumping movements of the insect's abdomen was measured.

The graph shows the results.



(a) Explain what caused

(i) the rise in the rate of abdominal pumping movements between 1.5 and 2.0 minutes,

_____

_____

(1)

(ii) the fall in the rate of abdominal pumping movements between 2.0 and 3.0 minutes.

_____

_____

_____

_____

(2)

(b) The rate of abdominal pumping movements increases between 3.0 and 3.5 minutes. Suggest the advantage of this change to the locust.

_____

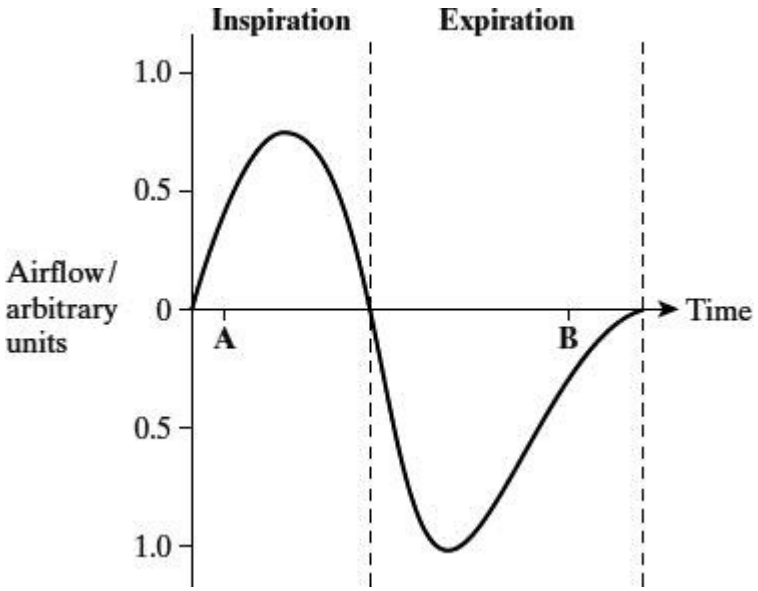
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(1)

(Total 4 marks)

Q42.

The graph shows airflow into and out of the lungs during a normal breath.



(a) (i) How will the concentration of carbon dioxide in the airflow differ at times **A** and **B**?

_____

_____

(1)

(ii) Describe the role of diffusion in producing this difference.

_____

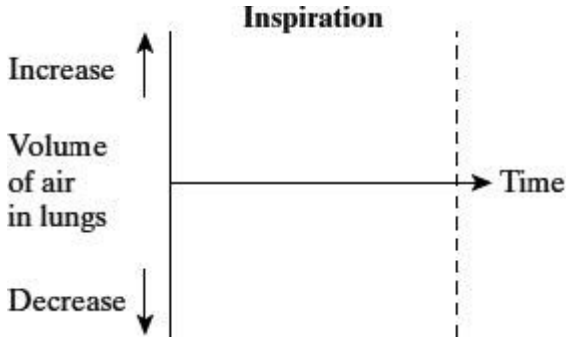
_____

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(2)

(b) Use information from the graph to sketch a curve on the axes below to show how the volume of air in the lungs changes during inspiration.



(2)

(c) The intercostal muscles are between the ribs. In normal breathing, describe the part played by the intercostal muscles

(i) during inspiration;

_____

_____

_____

_____

_____

_____

(3)

(ii) during expiration.

_____

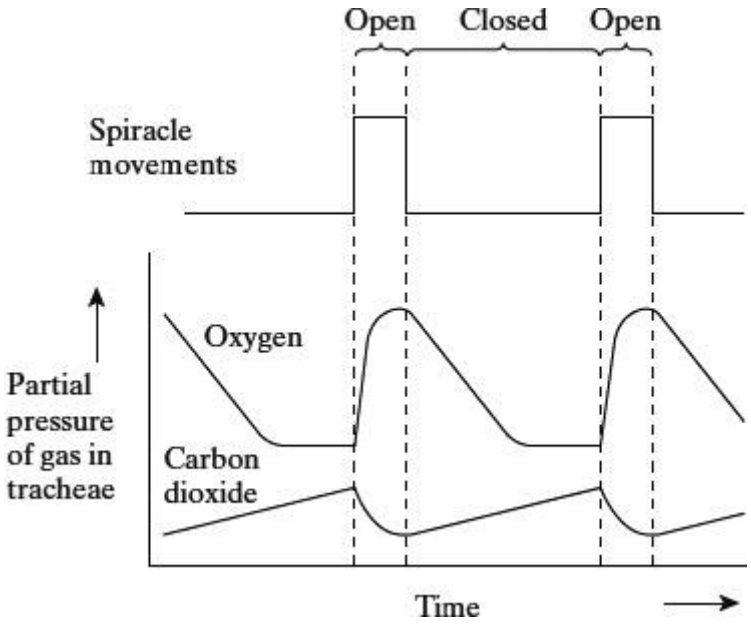
_____

(1)

(Total 9 marks)

Q43.

Many insects release carbon dioxide in short bursts even though they produce it at a constant rate. The diagram shows how this is achieved in one particular insect.



(a) Using information from the diagram, suggest what stimulates the spiracles to open.

_____

_____

(1)

(b) Explain what causes the oxygen concentration in the tracheae to fall when the spiracles are closed.

_____

_____

_____

_____

(2)

(c) The insect lives in dry conditions. Suggest an advantage of the pattern of spiracle movements shown in the diagram.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q44.

In the lungs, the alveoli are the site of gas exchange.

(a) A large number of small alveoli is more efficient in gas exchange than a smaller number of larger alveoli. Explain why.

_____

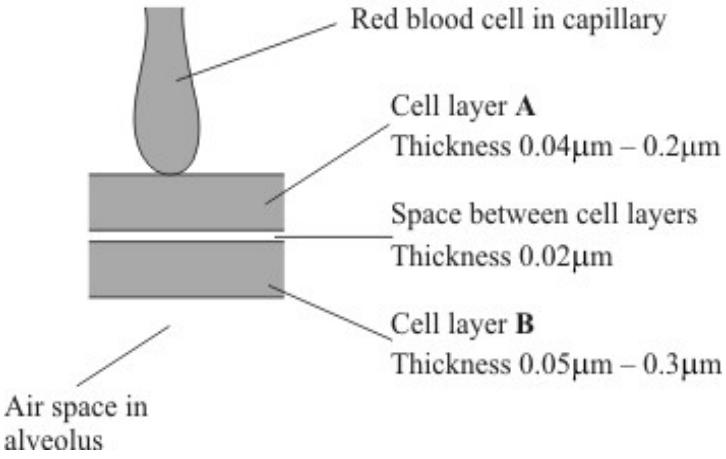
_____

_____

_____

(2)

(b) The diagram shows part of an alveolus and a capillary.



(i) Name the type of cells in layer **B**.

_____

(1)

(ii) What is the minimum distance a molecule of carbon dioxide diffuses from the blood plasma to the air space in the alveolus?

_____

(1)

(c) Just before a person starts to exhale, the composition of the air in an alveolus differs from the composition of the air in the trachea.

(i) Give **two** ways in which the composition would differ.

1. _____

2. _____

(1)

(ii) Explain what causes this difference in composition between the air in the alveolus and the air in the trachea.

_____

_____

(1)

(d) The partial pressure of a gas is a measure of the amount of gas that is present.
The partial pressure of carbon dioxide in blood going to the lungs is 6.3 kPa.
The partial pressure of carbon dioxide in an alveolus is 5.3 kPa.

(i) Through which vessel does blood leave the heart to go to the lungs?

_____

(1)

(ii) Suggest why blood returning to the heart from the lungs contains some carbon dioxide.

_____

_____

_____

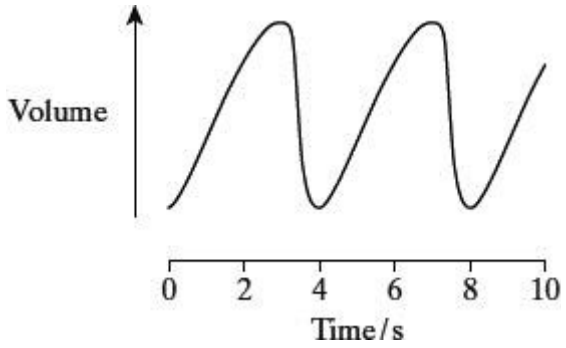
_____

(2)

(Total 9 marks)

Q45.

A person was sitting at rest and breathing normally. A recording was made of the changes in the volume of air in his lungs over a ten-second period. The diagram shows this recording.



(a) Describe the part played by muscles in bringing about the change between 3 and 4 seconds.

_____

_____

(1)

(b) Describe how an increase in lung volume leads to air entering the lungs.

_____

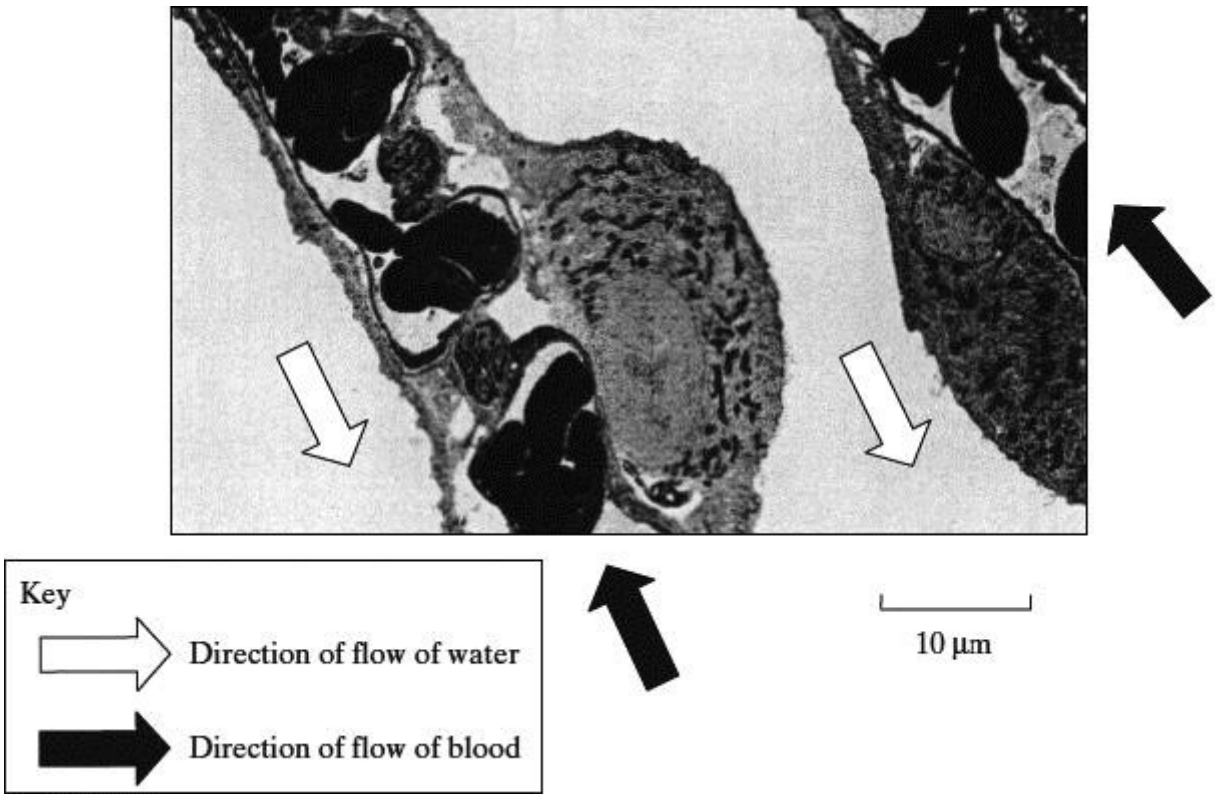
_____

(1)

(Total 2 marks)

Q46.

The electron micrograph shows a section through a fish gill. The directions of flow of water and of blood are indicated by arrows.



Source: www.ucdavis.edu/mjguinan

(a) Calculate the minimum distance that a molecule of oxygen would have to travel from the water to a red blood cell. Give your answer in micrometres and show your working.

Answer _____ µm.

(2)

(b) Explain how the relationship between the direction of flow of water and of blood shown in the micrograph is useful to a fish.

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q47.

(a) Describe the part played by the diaphragm in causing air to enter the lungs during breathing.

_____

_____

_____

_____

_____

_____

(3)

Seals are mammals. They have lungs and must breathe air. They can dive and remain under water for a long time. The table shows the flow of blood to the lungs and to the diaphragm in a seal when it is on land and when it is under water.

Organ	Blood flow / $cm^3\ min^{-1}\ g^{-1}$	
	On land	Under water
Lungs	0.88	0.52
Diaphragm	0.21	0.02

(b) Explain why the figures in the table are given per gram of tissue.

_____

_____

_____

_____

(2)

(c) Calculate the percentage by which blood flow to the lungs is reduced when a seal is swimming under water. Show your working.

Answer _____

(2)

(d) There is a greater percentage reduction in blood flow to the diaphragm than to the lungs during a dive. Explain the advantage to a diving seal of

(i) blood continuing to flow to the lungs;

_____

_____

(1)

(ii) a large reduction in blood flow to the diaphragm.

_____

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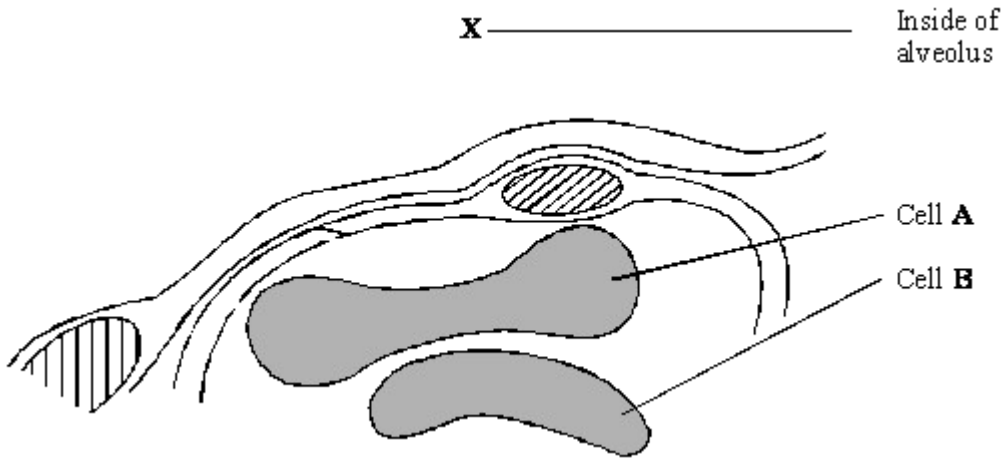
_____

(2)

(Total 10 marks)

Q48.

The drawing shows an electron micrograph of a section through part of an alveolus from a lung.



(a) Describe the path of a molecule of oxygen from the air in the alveolus at **X** to the plasma membrane of cell **A**.

_____

_____

(1)

(b) Cell **A** is a eukaryotic cell. Give **two** features that may be found in a prokaryotic cell which are not found in cell **A**.

1. _____

_____

2. _____

_____

(2)

(c) Cells **A** and **B** are biconcave discs. Explain **one** advantage of a biconcave disc over a spherical cell of the same volume in transporting oxygen.

_____

_____

_____

_____

(2)

(d) The diameter of a human red blood cell is 7 μm.

(i) Calculate the magnification of the drawing. Show your working.

Magnification = _____

(2)

(ii) In calculating the magnification, what assumption did you have to make about how the section was cut?

_____

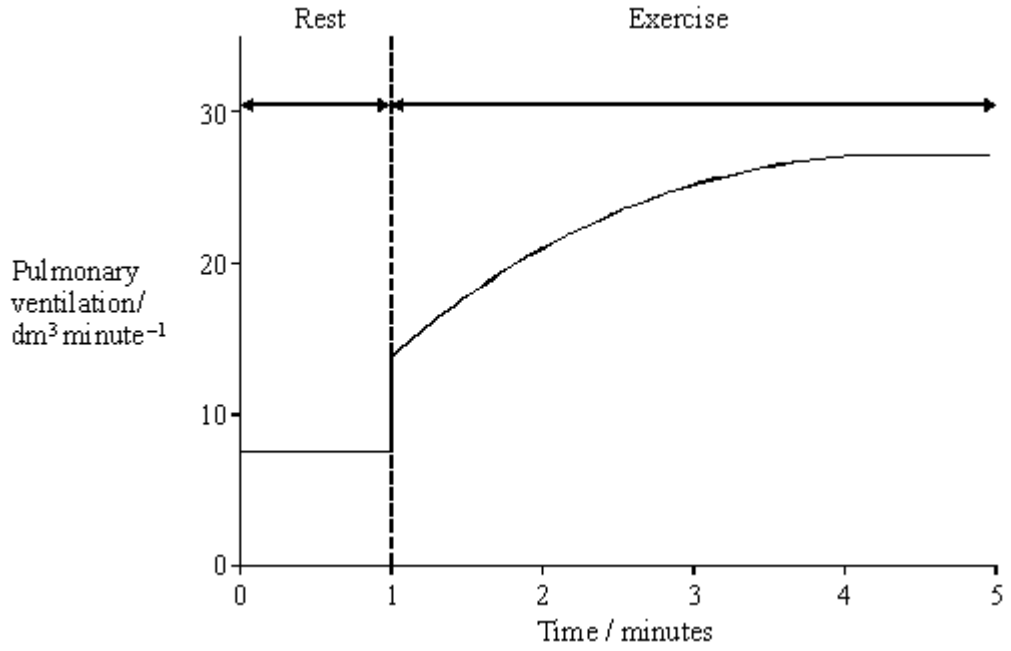
_____

(1)

(Total 8 marks)

Q49.

The graph shows how pulmonary ventilation changes during a period of exercise.



(a) Describe how pulmonary ventilation changed during the period of exercise.

_____

_____

_____

(1)

(b) After 4 minutes of exercise, the breathing rate was 20 breaths per minute. Explain how you could use this information and the graph to calculate tidal volume.

_____

_____

_____

_____

(2)

(c) When a person starts to breathe out, the percentage of oxygen in the air first exhaled is the same as the percentage of oxygen in the atmospheric air. Explain why.

_____

_____

_____

(2)

(Total 5 marks)

Q50.

Lung cancer, chronic bronchitis and coronary heart disease (CHD) are associated with

smoking. **Tables 1** and **2** give the total numbers of deaths from these diseases in the UK in 1974.

Table 1 Men

Age/years	Number of deaths (in thousands)		
	lung cancer	chronic bronchitis	coronary heart disease
35 - 64	11.5	4.2	31.7
65 - 74	12.6	8.5	33.3
75+	5.8	8.1	29.1
Total (35 - 75+)	29.9	20.8	94.1

Table 2 Women

Age/years	Number of deaths (in thousands)		
	lung cancer	chronic bronchitis	coronary heart disease
35 – 64	3.2	1.3	8.4
65 – 74	2.6	1.9	18.2
75+	1.8	3.5	42.3
Total (35 – 75+)	7.6	6.7	68.9

(i) Using an example from the tables, explain why it is useful to give data for men and women separately.

_____

_____

_____

(2)

(ii) Data like these are often given as percentages of people dying from each cause.

Explain the advantage of giving these data as percentages.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q51.

(a) Describe the features of fish gills that give them a large surface area.

_____

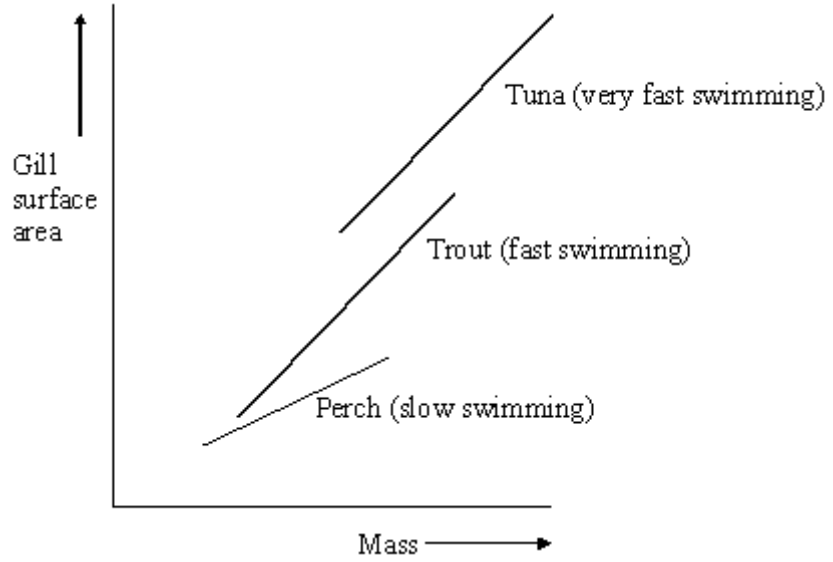
_____

_____

_____

(2)

The graph shows the relationship between gill surface area and body mass for three species of fish.



(b) (i) Describe the relationships between gill surface area, mass and swimming speed shown in the diagram.

_____

_____

(1)

(ii) Explain the relationship between gill surface area and swimming speed.

_____

_____

_____

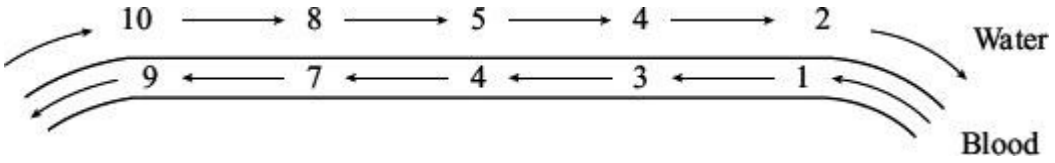
_____

(2)

(Total 5 marks)

Q52.

(a) The diagram represents the flow of water and blood through the gills of a fish. The figures give relative oxygen concentrations.



Use the information in the diagram to explain the advantage of the countercurrent flow.

_____

_____

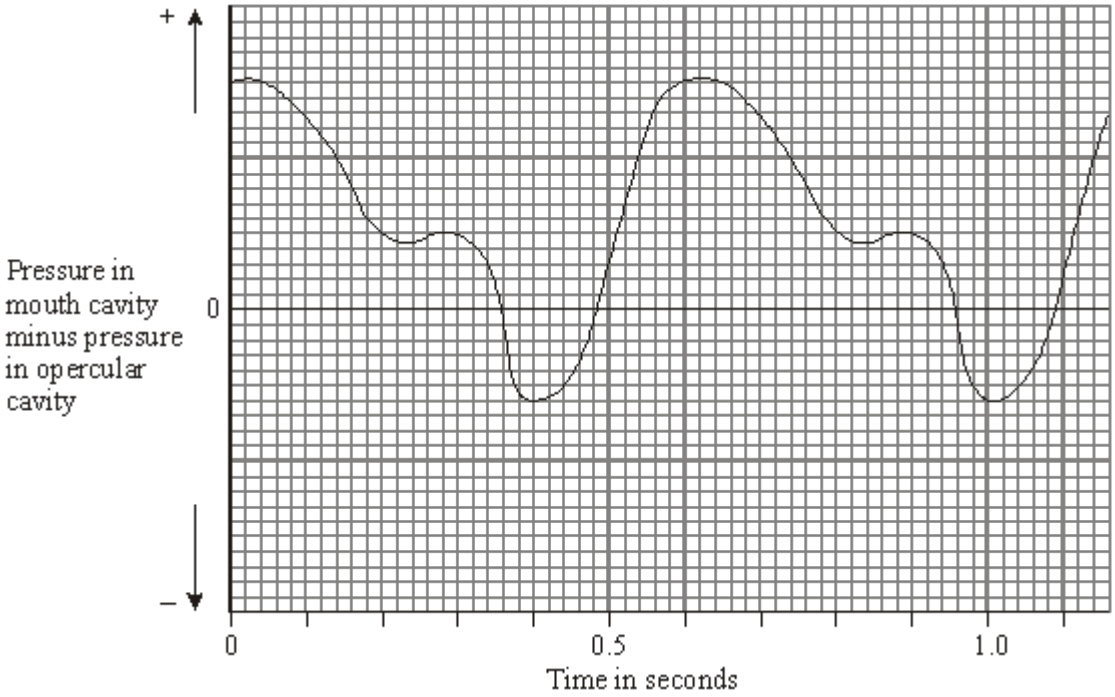
_____

_____

_____

(2)

(b) In the ventilation cycle of a fish, water enters the mouth cavity and then passes through the gills into the opercular cavity. The graph shows the difference in pressure between the mouth cavity and the opercular cavity.



Calculate the number of ventilation cycles per minute of the fish. Show your working.

Answer _____

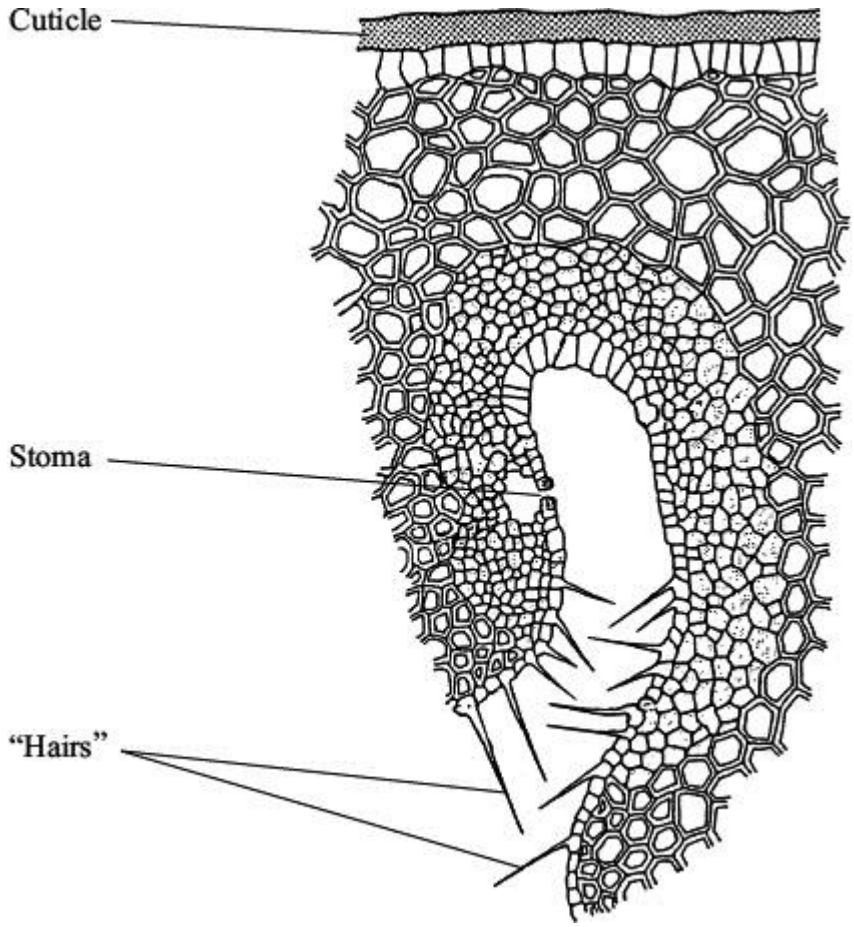
(2)

(Total 4 marks)

Q53.

Figure 1 shows a single stoma and surrounding cells from the leaf of a xerophytic plant.

Figure 1



(i) Explain how the cuticle reduces water loss.

_____

_____

(1)

(ii) Explain how **one** of the other labelled parts reduces water loss.

_____

_____

_____

_____

(2)

(Total 3 marks)

Q54.

(a) The photograph shows part of the gill of a fish as seen through a light microscope. It is magnified × 400.



(i) Explain how the structure of the gill makes oxygen uptake efficient.

_____

_____

_____

_____

(2)

(ii) Water containing dissolved oxygen flows over the gill in the opposite direction to the blood flow inside. Explain why this arrangement is important for efficient oxygen uptake.

_____

_____

_____

_____

(2)

(b) There is a one-way flow of water over the gills of a fish whereas there is a two-way flow of air in the lungs of a mammal. Suggest **one** advantage to a fish of this one-way flow of water over its gills.

_____

_____

(1)

(Total 5 marks)

Q55.

(a) Describe how air is taken into the lungs.

_____

_____

_____

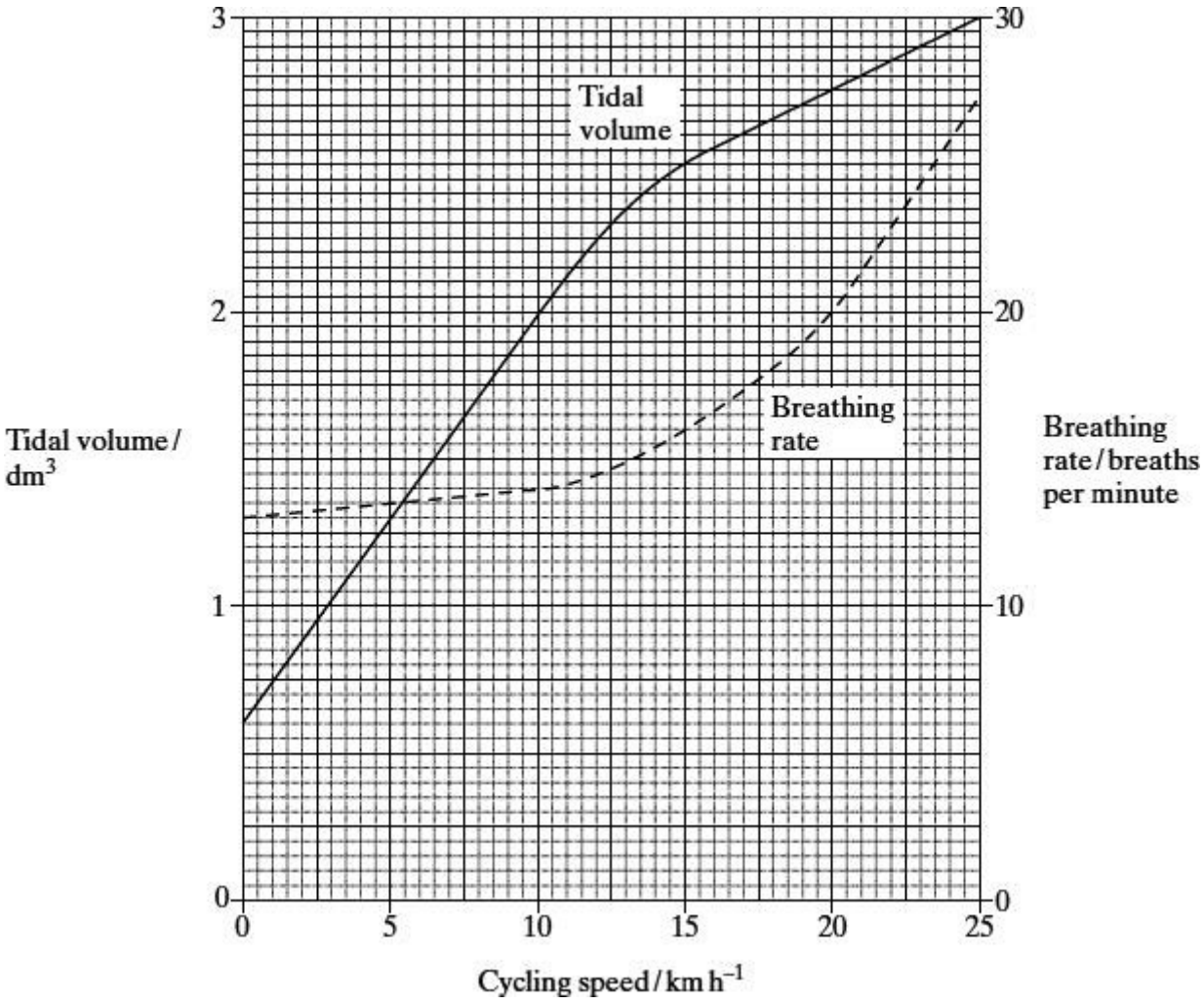
_____

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(3)

The volume of air breathed in and out of the lungs during each breath is called the tidal volume. The breathing rate and tidal volume were measured for a cyclist pedalling at different speeds. The graph shows the results.



(b) Describe the **two** curves.

(i) Tidal volume

_____

_____

_____

(ii) Breathing rate

_____

_____

_____

(2)

(c) Calculate the total volume of air breathed in and out per minute when the cyclist is cycling at 20 km h^{-1}. Show your working.

_____ dm^3

(2)

(Total 7 marks)

Q56.

(a) Describe and explain how fish maintain a flow of water over their gills.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Describe and explain how the structure of the mammalian breathing system enables efficient uptake of oxygen into the blood.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 10 marks)

Q57.

(a) When first hatched, the young of some species of fish are less than 2 mm long. Explain how these young fish get enough oxygen to their cells without having gills.

_____

_____

_____

_____

(2)

(b) Mackerel are fast swimming fish whereas toadfish only swim slowly. The table shows some features of the gills of these fish.

	Thickness of lamellae / µm	**Number of lamellae per mm of gill length**
Mackerel	5	32
Toadfish	35	8

Use evidence from the table to explain how mackerel are able to swim faster than toadfish.

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(3)

(Total 5 marks)

Q58.

This question should be written in continuous prose, where appropriate.
Quality of Written Communication will be assessed in the answer.

(a) Explain how the ventilation mechanism of a fish and the structure of its gills result in the efficient uptake of oxygen from water.

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(6)

Table 1 compares some features of water and air.

Feature	Water	Air
Relative density	1000	1
Maximum concentration of oxygen / $cm^3\ dm^{-3}$	9	130

Table 1

Table 2 shows some features of gas exchange in a fish and in a mammal.

Feature	Fish	Mammal
Percentage of oxygen extracted from water or air	80	25
Oxygen consumption at rest / $cm^3\ kg^{-1}\ hour^{-1}$	100	200

Table 2

(b) (i) The fish has a body mass of 0.2 kg. Calculate the volume of water it will need to pass over its gills each hour to supply the oxygen required when resting. Show your working.

Answer _____ dm^3 / $hour^{-1}$

(2)

(ii) Ventilation in mammals involves movement of air to and from the gas exchange surface in a tidal pattern. Using information in the tables, explain why it is easier to move water over the gas exchange surface of a fish in one direction rather than in a tidal pattern.

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(2)

(c) A rise in the temperature of water decreases the amount of oxygen dissolved in the water. As the water temperature rises, the rate of ventilation in a fish also rises. Explain the advantage of this.

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(2)

(Total 12 marks)