

## Q1.

- (a) Describe and explain **one** feature of the alveolar epithelium that makes the epithelium well adapted as a surface for gas exchange. Do **not** refer to surface area or moisture in your answer.

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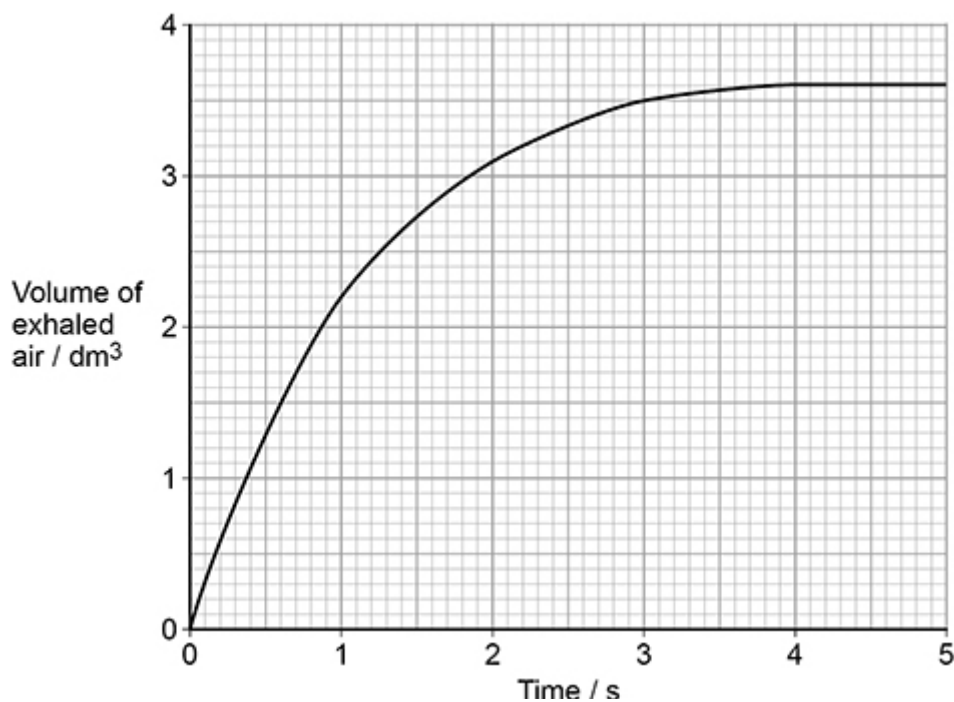
(2)

Doctors measure the health of lungs by calculating the FEV<sub>1</sub>:FVC ratio.

- FEV<sub>1</sub> is the maximum volume of air exhaled in one second.
- FVC is the maximum volume of air exhaled in one breath.

The minimum FEV<sub>1</sub>:FVC ratio of healthy lungs is 0.7:1

A man with the lung disease emphysema inflated his lungs fully. He then exhaled as much of this air as quickly as possible in one breath. The figure below shows how the volume of exhaled air changed during this breath.



- (b) Use the information provided to determine the FEV<sub>1</sub>:FVC ratio of this man's lungs.

Go on to determine how many times greater the minimum ratio of healthy lungs is than his ratio.

FEV<sub>1</sub>:FVC ratio of man's lungs = \_\_\_\_\_

How many times greater? \_\_\_\_\_

(2)

- (c) Tidal volume is the volume of air inhaled and exhaled during a single breath when a person is resting. The tidal volume in a person with emphysema is reduced compared with the tidal volume in a healthy person.

Suggest and explain how a reduced tidal volume affects the exchange of carbon dioxide between the blood and the alveoli.

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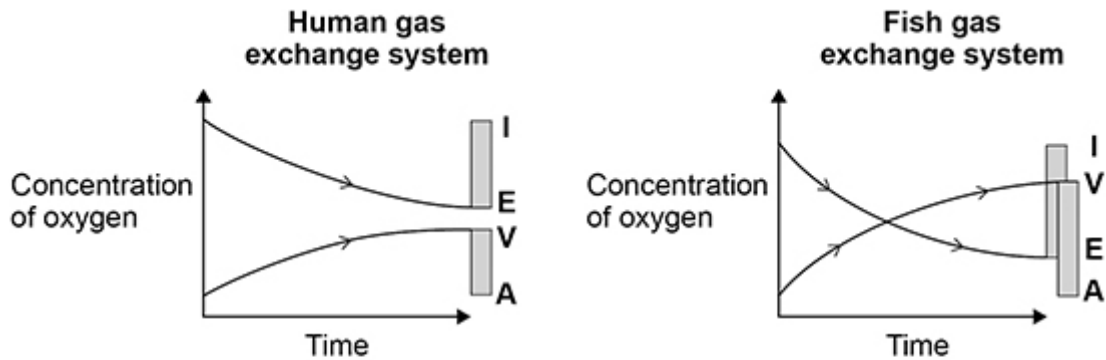
(3)

(Total 7 marks)

**Q2.**

- (c) **Figure 2** shows changes in concentration of oxygen in two gas exchange systems.

**Figure 2**



**Key**

- I Air/water entering the gas exchange system
- E Air/water leaving the gas exchange system
- A Arterial blood entering the gas exchange system
- V Venous blood leaving the gas exchange system

A student studied **Figure 2** and concluded that the fish gas exchange system is more efficient than the human gas exchange system.

Use **Figure 2** to justify this conclusion.

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(2)

- (d) Explain how the counter-current principle allows efficient oxygen uptake in the fish gas exchange system.

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(2)

**Q3.**

(a) Describe and explain the mechanism that causes lungs to fill with air.

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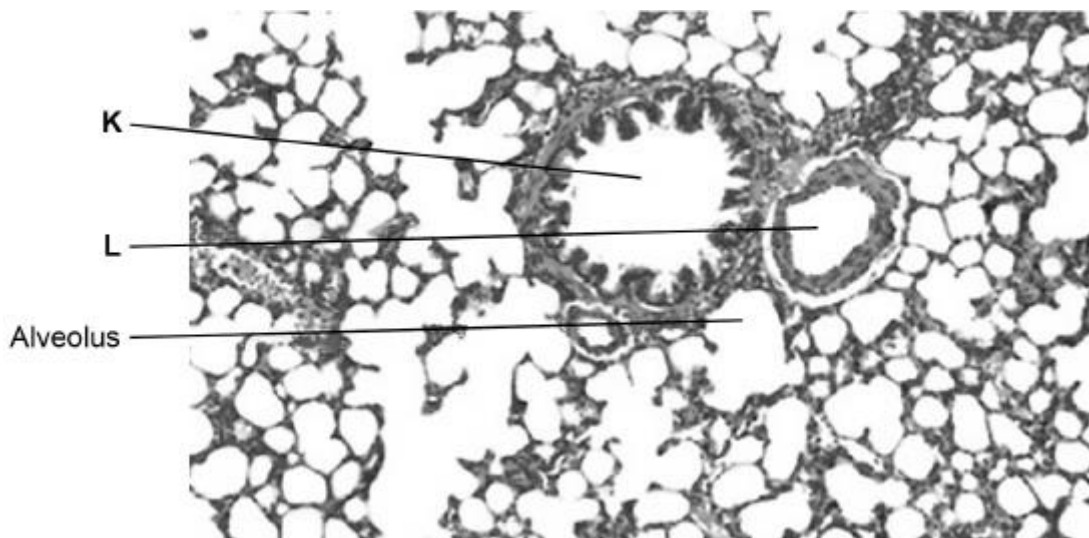
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(3)

A scientist observed sections of lung tissue using an optical microscope.

The image below shows one of these sections.

**K** is an air-filled tube and **L** is a blood vessel.



(b) Identify the structures labelled **K** and **L**.

**K** \_\_\_\_\_

**L** \_\_\_\_\_

(1)

(c) Two solutions often used to stain tissues are haematoxylin solution and iodine solution.

- Haematoxylin solution stains DNA a blue colour.
- Iodine solution stains starch a blue-black colour.

The scientist used haematoxylin solution and **not** iodine solution to stain the lung tissue.

Suggest why.

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(2)

(d) Scientists investigated the link between the lung disease asthma and three risk factors. They studied a large number of people. They recorded if the people had asthma and if they:

- were obese
- burned wood indoors as a fuel
- lived in a house with a cat or dog.

The scientists used a statistical test to calculate the probability of the link between asthma and each risk factor being due to chance.

The table below shows their results.

Risk Factor	Probability (P value)
Obese	< 0.001
Burned wood indoors	= 0.06
Lived with a cat or dog	< 0.05

A student who looked at these results concluded that all three risk factors are linked with asthma. Evaluate this conclusion.

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(3)  
(Total 9 marks)

**Q4.**

- (a) Particulate matter is solid particles and liquid particles suspended in air. Polluted air contains more particulate matter than clean air.

A high concentration of particulate matter results in the death of some alveolar epithelium cells. If alveolar epithelium cells die inside the human body they are replaced by non-specialised, thickened tissue.

Explain why death of alveolar epithelium cells reduces gas exchange in human lungs.

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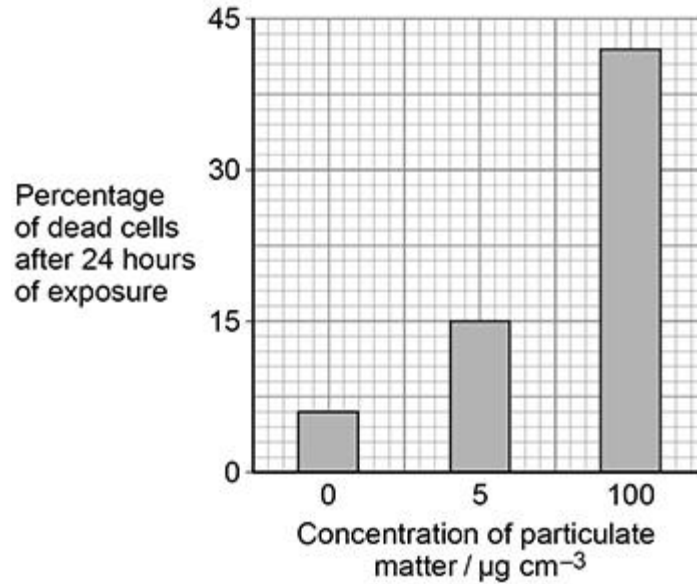
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(3)

Scientists grew alveolar epithelium cells and exposed the epithelium cells to different concentrations of particulate matter. They calculated the percentage of these alveolar epithelium cells that died after 24 hours of exposure to particulate matter. Their results are shown in the graph below.



- (b) Do the data in the graph above show a linear relationship between concentration of particulate matter and percentage of dead cells?

Use suitable calculations to justify your answer.

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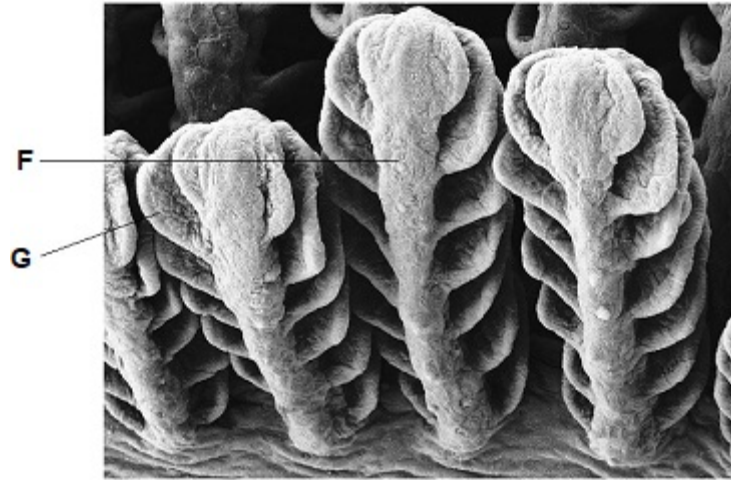
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Space for your calculations:

(2)  
(Total 5 marks)

**Q5.**

Below is an image of a fish gill taken using a scanning electron microscope.



(a) Identify structures labelled **F** and **G**.

**F** \_\_\_\_\_

**G** \_\_\_\_\_

(1)

(b) Describe and explain the advantage of the counter-current principle in gas exchange across a fish gill.

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(3)

(Total 4 marks)



**Q6.**

The water potential of leaf cells is affected by the water content of the soil.

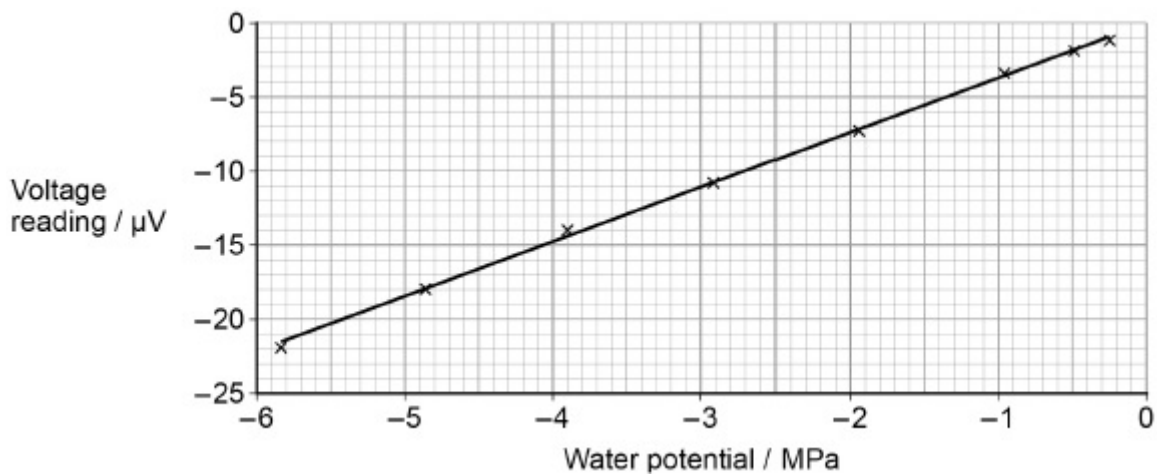
Scientists grew sunflower plants. They supplied different plants with different volumes of water.

After two days, they determined the water potential in the leaf cells by using an instrument that gave a voltage reading.

The scientists generated a calibration curve to convert the voltage readings to water potential.

**Figure 1** shows their calibration curve.

**Figure 1**



- (d) Sunflowers are not xerophytic plants. The scientists repeated the experiment with xerophytic plants.

Suggest and explain **one** way the leaf growth of xerophytic plants would be different from the leaf growth of sunflowers in **Figure 2**.

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(2)

- (e) Use your knowledge of gas exchange in leaves to explain why plants grown in soil with very little water grow only slowly.

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(2)

**Q7.**

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

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(2)

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

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(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  $\pm 2$  standard deviations from the mean includes over 95% of the data.



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(4)

(Total 8 marks)

**Q8.**

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

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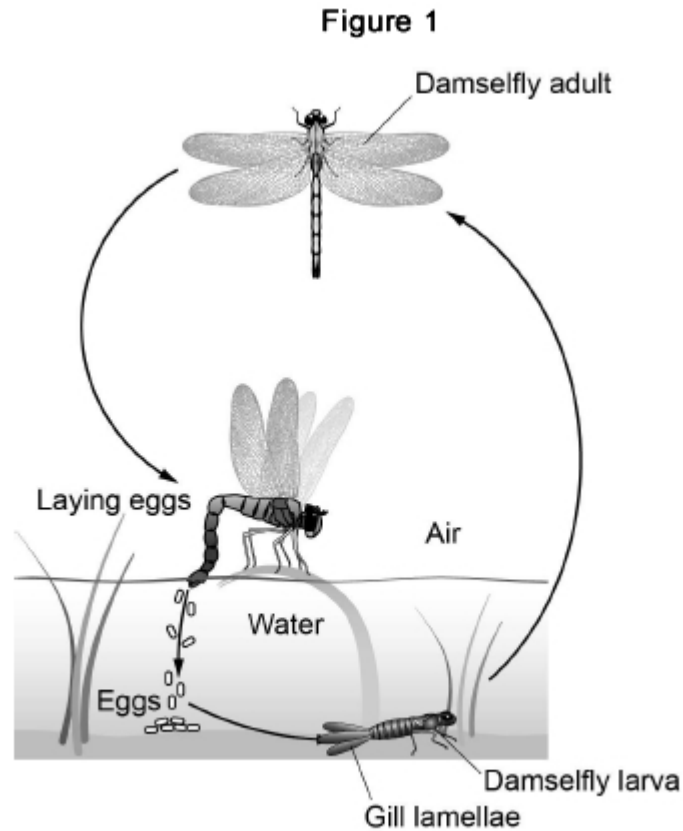
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(6)

Q9.

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



(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. \_\_\_\_\_

\_\_\_\_\_

3. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(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 ( $\pm$ uncertainty / mm)	1.61 ( $\pm$ 0.19)
Mean width / mm ( $\pm$ uncertainty / mm)	6.12 ( $\pm$ 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)

**Q10.**

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

1.

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2.

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(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)



