

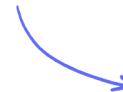
Structured Questions: Paper 2

# 6.4 Gas Exchange

6.4.1 Ventilation: Function & Structures / 6.4.2 Ventilation: Mechanism / 6.4.3 Lung Diseases / 6.4.4 Skills: Monitoring Ventilation

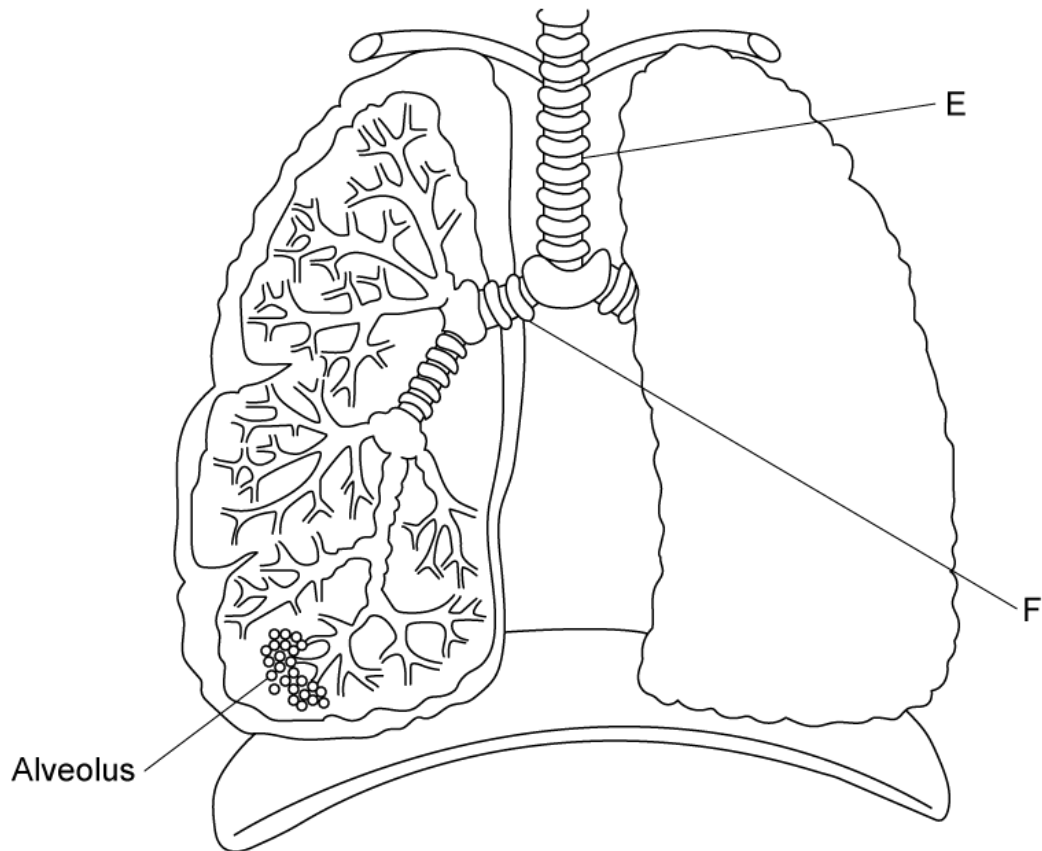
|                      |             |
|----------------------|-------------|
| Easy (5 questions)   | /36         |
| Medium (5 questions) | /49         |
| Hard (5 questions)   | /60         |
| <b>Total Marks</b>   | <b>/145</b> |

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# Easy Questions

- 1 (a) Some of the structures involved with the movement of air into the lungs are shown in the diagram below.



Identify structures **E** and **F**.

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(2 marks)

- (b) Both structures **E** and **F** contain cartilage.

State the role of cartilage in structures **E** and **F**.

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**(1 mark)**

**(c)** The alveolus in the diagram in part a) is lined with cells known as Type I pneumocytes.

Explain how Type I pneumocytes are adapted to their function.

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**(2 marks)**

**(d)** In amongst the Type I pneumocytes described in part c) are cells known as Type II pneumocytes. Type II pneumocytes secrete a solution which covers the lining of the alveolus.

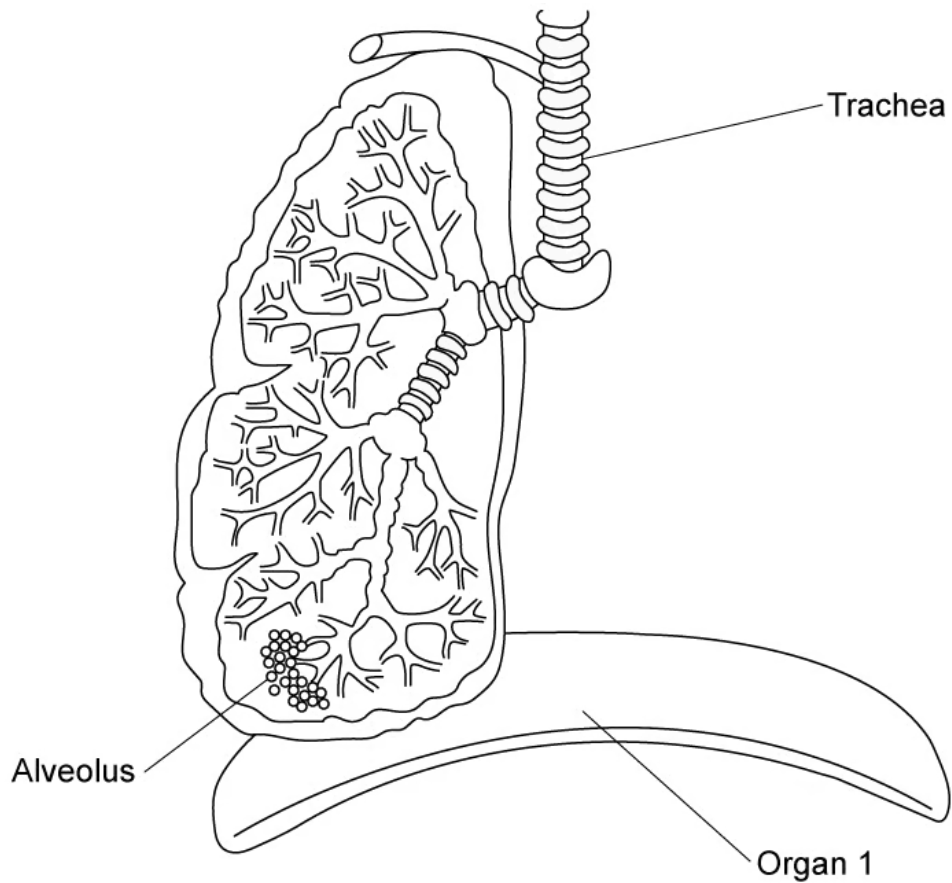
State **two** ways in which the solution secreted by Type II pneumocytes aids alveolar function.

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**(2 marks)**

2 (a) The diagram below shows some of the structures in the human body involved with the ventilation process.



Identify **Organ 1** in the diagram above.

.....  
(1 mark)

(b) Describe how the contraction of **Organ 1** in part a) aids the inspiration process.

.....  
.....  
(2 marks)

(c) Organ 1 is part of an antagonistic pair of muscles.

Explain what is meant by the term **antagonistic pair**.

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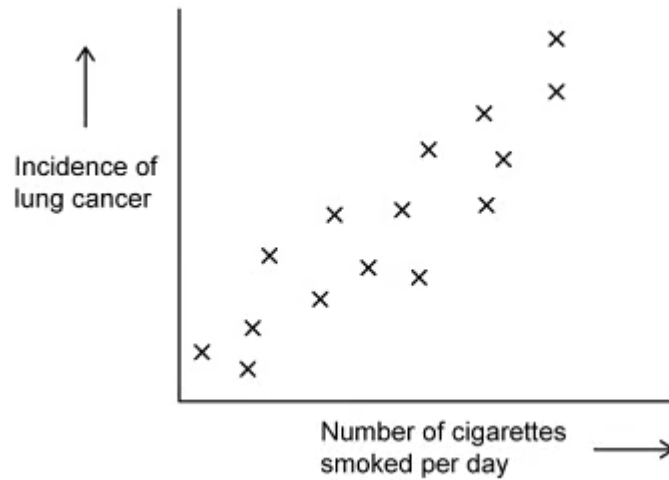
(2 marks)

- (d) Aside from the antagonistic pair that includes Organ 1, identify **one other** antagonistic pair of muscles involved with inspiration and expiration.

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(1 mark)

3 (a) The graph below shows the results of a study that monitored the number of cigarettes smoked per day alongside incidence of lung cancer.



Two students looked at the graph and came to different conclusions:

Student **A** concluded that smoking more cigarettes causes lung cancer.

Student **B** concluded that there is a connection between smoking more cigarettes and lung cancer.

State, with a reason, which student reached the correct conclusion from looking at the graph above.

.....

.....

**(2 marks)**

(b) Outline how the study described in part a) should have been designed in order to gain **valid** evidence regarding the link between cigarettes and lung cancer.

.....

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**(2 marks)**

- (c) Other research into cigarettes has shown that the smoke produced when tobacco is burned contains mutagenic chemicals.

Explain how tobacco smoke can cause lung cancer.

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**(2 marks)**

- (d) List **three** symptoms associated with lung cancer.

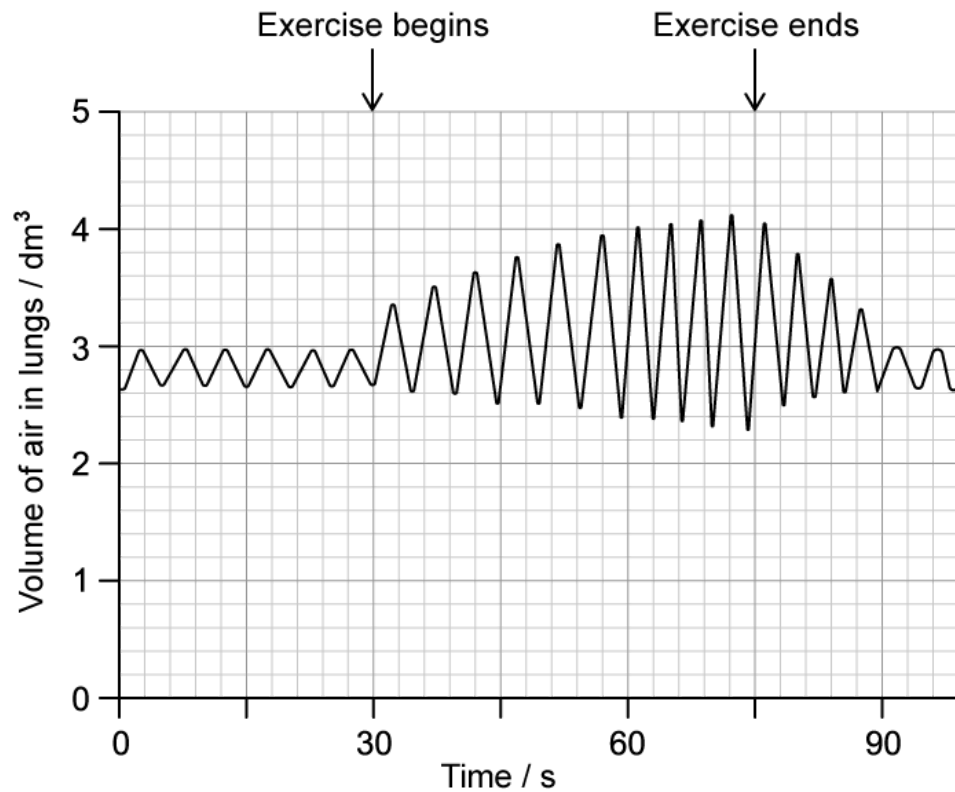
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**(3 marks)**

- 4 (a) A group of students investigated the effect of physical activity on ventilation. The graph below shows the results of their investigation.



Calculate the ventilation rate while at rest.

.....  
(1 mark)

- (b) Describe the effects of exercise on ventilation shown in the graph in part a).

.....  
(2 marks)

- (c) Emphysema is a lung condition that can cause shortness of breath and breathing difficulties, especially during exercise.

Outline why emphysema can lead to shortness of breath and breathing difficulties.



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(2 marks)

(d) State **one** factor that increases the risk of emphysema.

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(1 mark)

**5 (a)** *One mark is available for clarity of communication throughout this question.*

Outline the process of forced, or active, expiration.

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**(4 marks)**

**(b)** Describe how the effect of mild and vigorous exercise on ventilation can be monitored.

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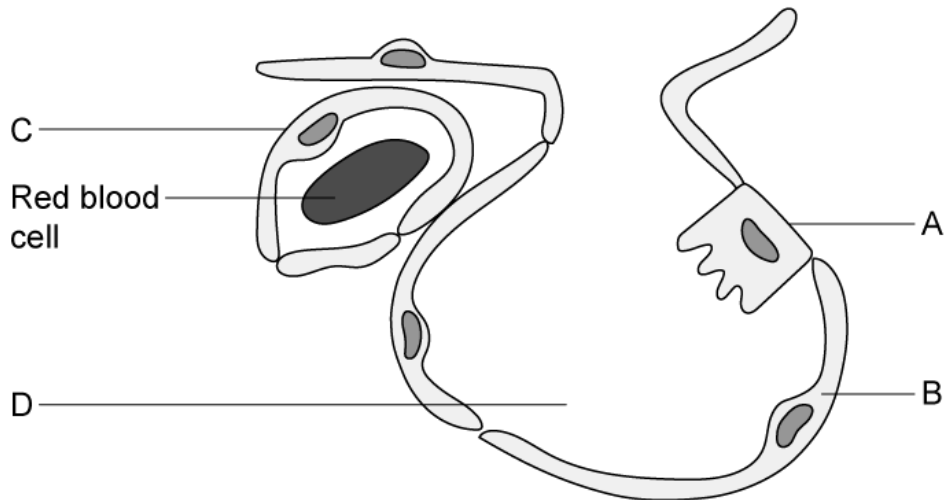
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**(4 marks)**

# Medium Questions

1 (a) The diagram below shows a cross section of an alveolus and associated structures.



- (i) Label the structures **A- D**
- (ii) Give an adaptation of structures **A** and **B**

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**(2 marks)**

(b) Describe the route taken by an oxygen molecule from an alveolus to the blood.

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**(2 marks)**

(c) Explain how the fluid secreted by the epithelial cells of the alveolus helps to reduce surface tension and prevent adhesion of the alveolar surface.

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**(4 marks)**

**(d)** State the mode of molecular transport by which oxygen from air in the alveoli enters the blood in capillaries.

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**(1 mark)**

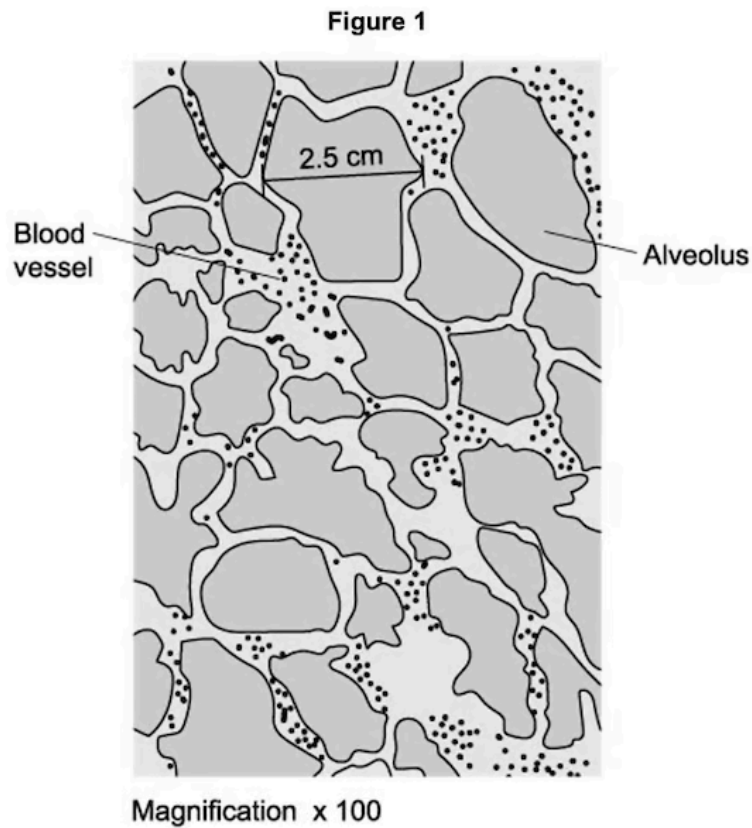
2 (a) Explain how the volume of the thorax increases during inspiration.

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(2 marks)

(b) The diagram below shows a micrograph of thinly sliced lung tissue.



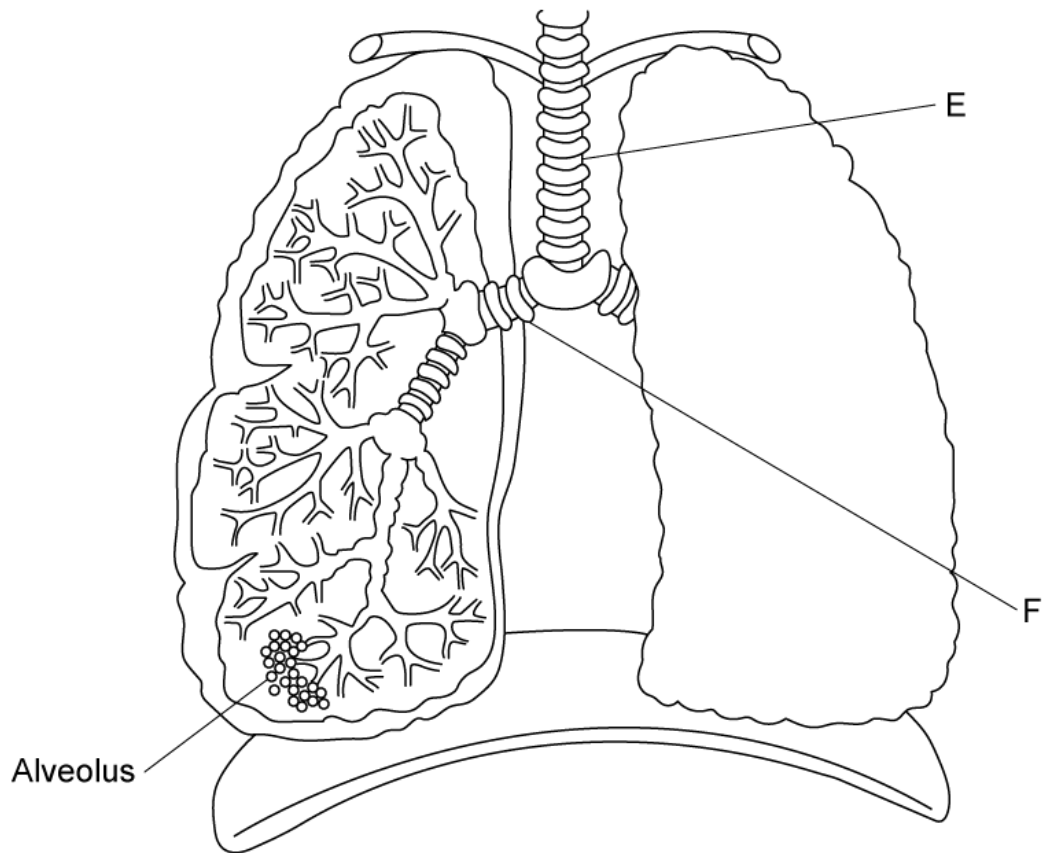
Calculate the actual size, in micrometres, of the alveolus diameter that has been measured in the diagram.

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(2 marks)

(c) The diagram below shows the structure of the human gas exchange system



Identify structures **E** and **F**

.....  
(1 mark)

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

.....  
.....  
.....  
(3 marks)

**3 (a)** Describe and explain **two** adaptations of alveoli that enable rapid gas exchange.

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**(2 marks)**

**(b)** Describe the route taken by a carbon dioxide molecule from the blood to the outside air.

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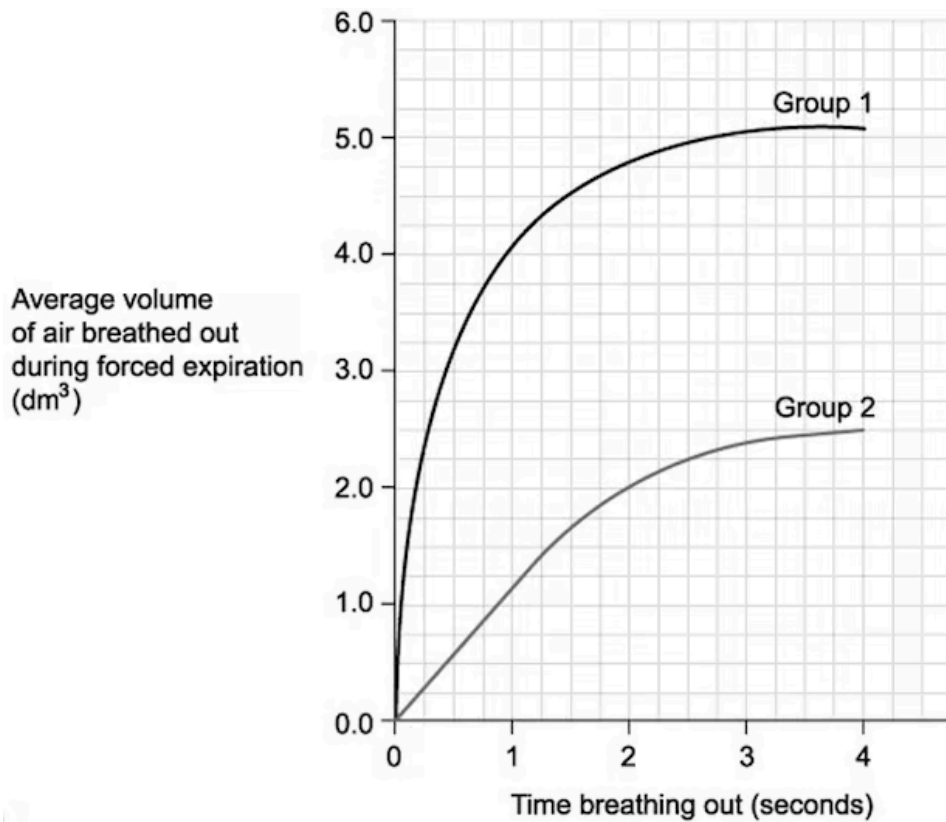
**(4 marks)**

**(c)** Two groups of people were asked to take part in a study. The individuals in group **1** were healthy and the individuals in group **2** had recently recovered from an asthma attack.

In the experiment each individual was asked to breathe in as deeply as they could. They then breathed out via forced expiration.

A study coordinator measured the volume of air that each individual breathed out during forced expiration.

The graph below shows the results.



The FEV (forced expiration volume) is the volume of air that an individual can breathe out within a single second.

Using the graph, calculate the percentage difference in the FEV for group 2 compared with group 1.

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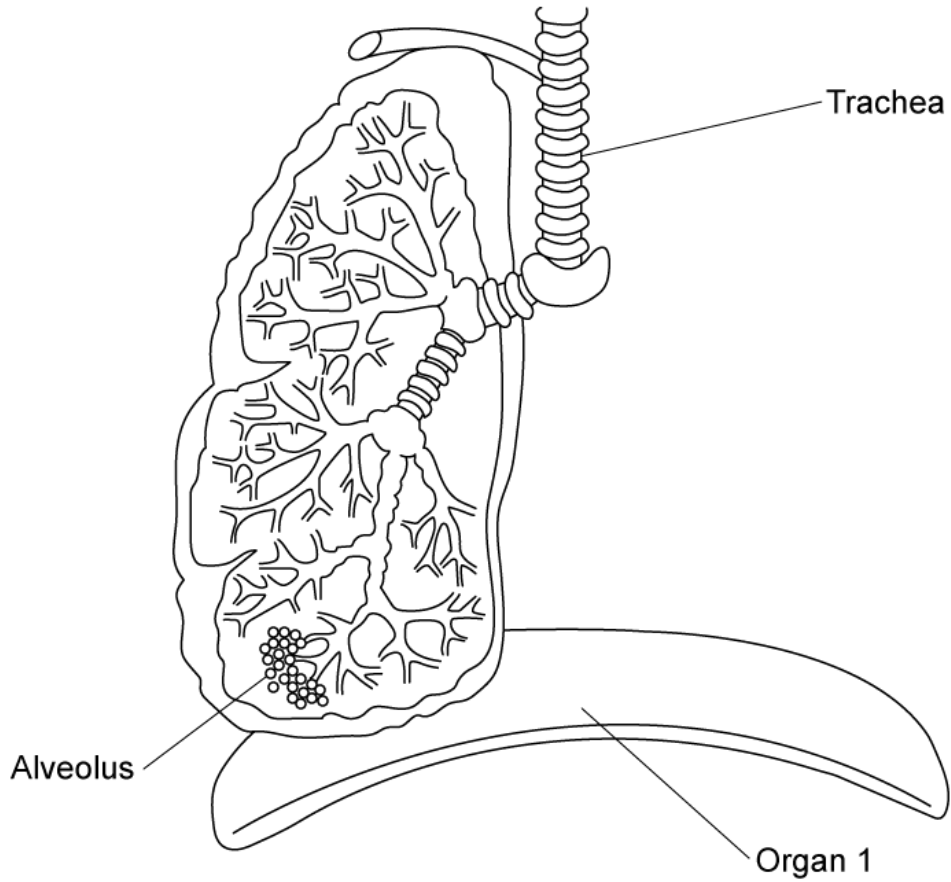
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**(2 marks)**



4 (a) The diagram below depicts a section of the human gas exchange system.

Figure 1



State the name of **Organ 1** and describe its role in breathing out.

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.....

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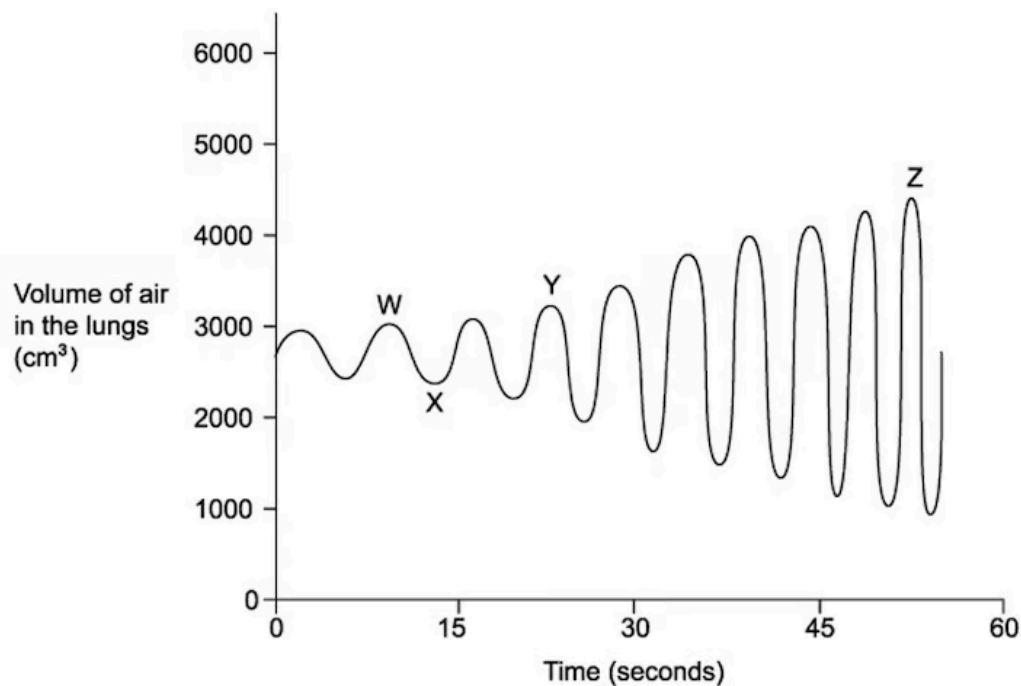
(3 marks)

(b) In normal and healthy lungs, an oxygen concentration gradient is maintained between the alveoli and the lung capillaries. Describe and explain how this is maintained.

.....

(4 marks)

(c) The graph below shows the changes in the volume of air in a woman's lungs while breathing.



Explain how the graph shows that the woman was breathing out between times **W** and **X**.

(1 mark)

(d) Muscle action during ventilation is described as antagonistic.

Outline what this means with reference to **one** example during ventilation.

(1 mark)

**5 (a)** *One mark is available for clarity of communication throughout this question.*

Emphysema is an example of a Chronic Obstructive Pulmonary Disease (COPD).

Explain the consequences smoking has on lung tissue and the increase of symptoms of emphysema.

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**(5 marks)**

**(b)** Lung cancer is another disease that affects the respiratory system. Many scientific studies have shown a link between smoking and lung cancer.

Describe other factors that may cause lung cancer.

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**(4 marks)**

**(c)** Doctors investigated the effect of the smoking habits of men on their non-smoking partners.

The doctors recruited 640 non-smoking partners, all of which were women aged 30 or older. They divided these women into groups according to the smoking habits of their husbands. After 15 years, the doctors recorded how many of the partners had died and their cause of death.

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

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

The results are shown in the table below.

| Cause of death | Relative Risk of Partner Dying |   |  |
|----------------|--------------------------------|---|--|
|                | Husband is a non-smoker        | Husband is a smoker (1-19 cigarettes/day) | Husband is a smoker (>19 cigarettes/day) |
| Lung cancer    | 1.00                           | 1.63                                      | 2.12                                     |
| Emphysema      | 1.00                           | 1.34                                      | 1.54                                     |
| Stomach cancer | 1.00                           | 1.13                                      | 1.15                                     |
| Breast cancer  | 1.00                           | 1.10                                      | 1.18                                     |
| Heart disease  | 1.00                           | 0.86                                      | 0.87                                     |

The scientists concluded from these data that if a husband smoked, it greatly increased the risk of his partner dying of certain diseases.

Evaluate this statement.

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**(6 marks)**

# Hard Questions

- 1 (a) Describe the pathway taken by a molecule of oxygen from the outside air to the blood of a human.

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(3 marks)

- (b) Premature babies can suffer from a deficiency of a substance referred to here as substance X. This can lead to a condition known as respiratory distress syndrome (RDS). The image below shows the possible appearance of the lung tissue of an RDS patient (left) and the appearance of normal lung tissue (right).

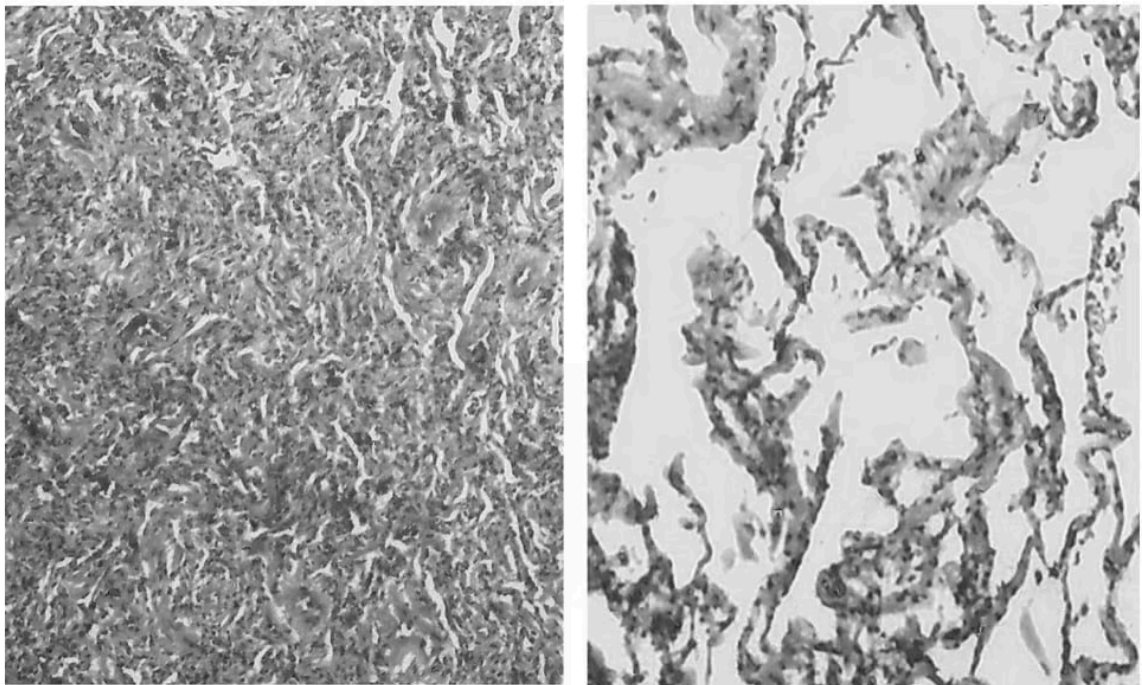


Image courtesy of Atlas of Pulmonary Pathology, licensed under the Creative Commons Attribution-ShareAlike 2.0 Generic license, and adapted and redistributed under conditions found at <https://creativecommons.org/licenses/by-sa/2.0/>

(i) Suggest the identity of substance **X**.

[1]

(ii) Explain the appearance of the RDS lung tissue in the image above.

[2]

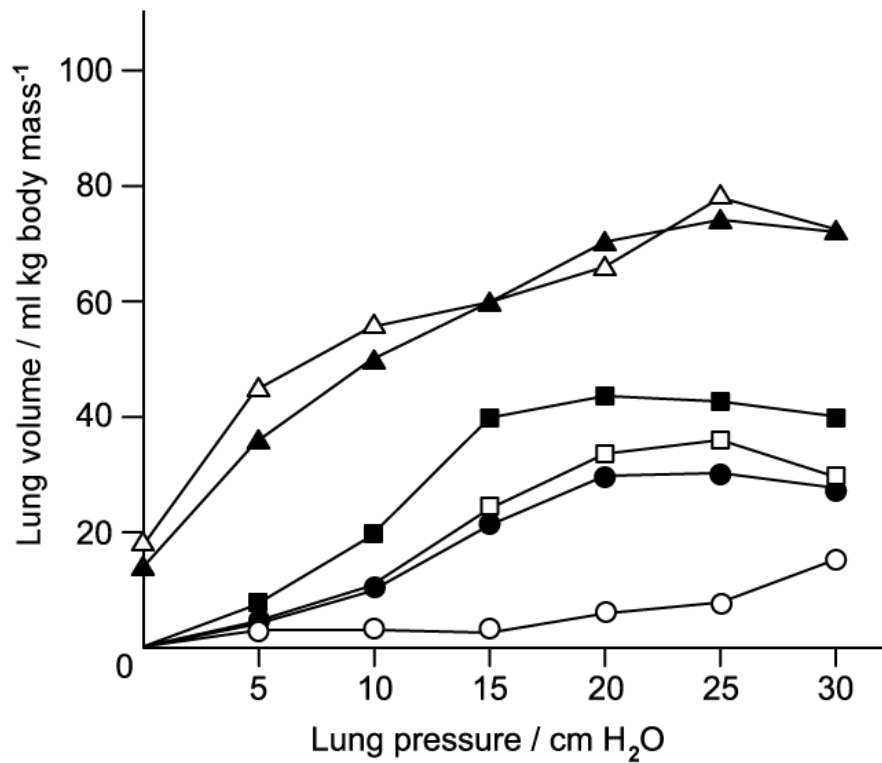
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**(3 marks)**

**(c)** RDS can be treated by the administration of an alternative form of substance **X** to the lungs. The graph below shows the effect of different variations of substance **X** on the lung volume of rabbits at different pressures. The variations include substance **X** isolated from sheep lungs, as well as synthetic versions of substance **X** that contain its separate lipid and protein components. Note that cm H<sub>2</sub>O is a unit of pressure.



**Key:** △ = Substance X from sheep lungs  
 ▲ = SP-B protein  
 ■ = SP-C protein  
 □ = Solution containing phospholipids  
 ● = SP-A protein  
 ○ = No treatment

Use the information provided to explain why each of the following statements is incorrect:

(i) Substance X is essential for lung expansion.

[1]

(ii) Phospholipids are the active component of substance X.

[1]

(iii) Substance X from sheep is the most effective treatment for RDS in premature babies.

[2]

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**(4 marks)**

- (d)** The form of substance **X** produced in mammalian lungs contains proteins known as SP-A and SP-D, which are known to be involved with the activation of phagocytes.

Suggest, with a reason, a symptom that would result from a deficiency of SP-A and SP-D proteins.

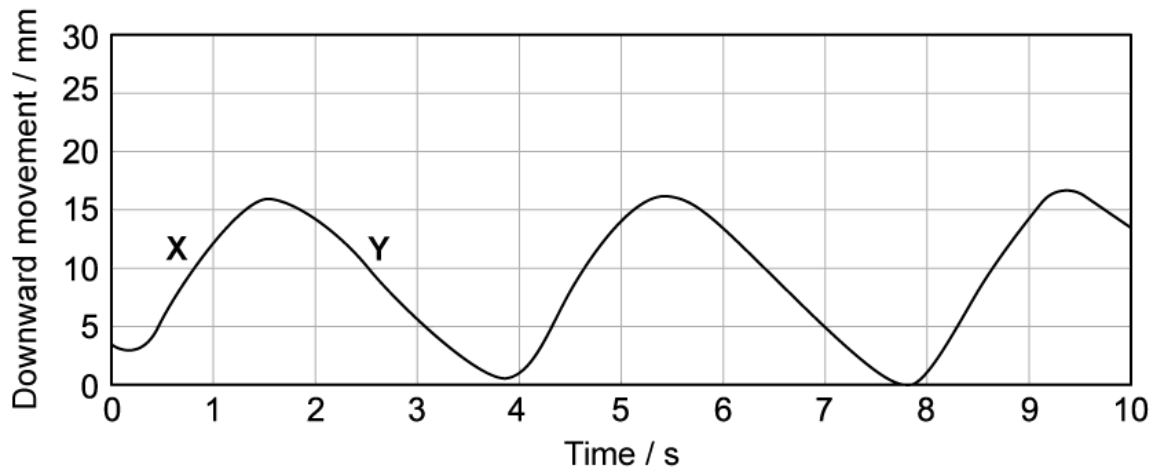
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**(2 marks)**



2 (a) A study was carried out that looked at the movement of the diaphragm during normal breathing. The graph below shows the diaphragm movement in a healthy 55-year-old male.



Calculate the breathing rate of the individual shown in the graph.

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.....

(2 marks)

(b) (i) Identify the ventilation processes occurring at the stages marked X and Y.

[1]

(ii) For the stage marked Y on the graph, name a muscle **other than** the diaphragm involved at this stage **and** identify its state.

[2]

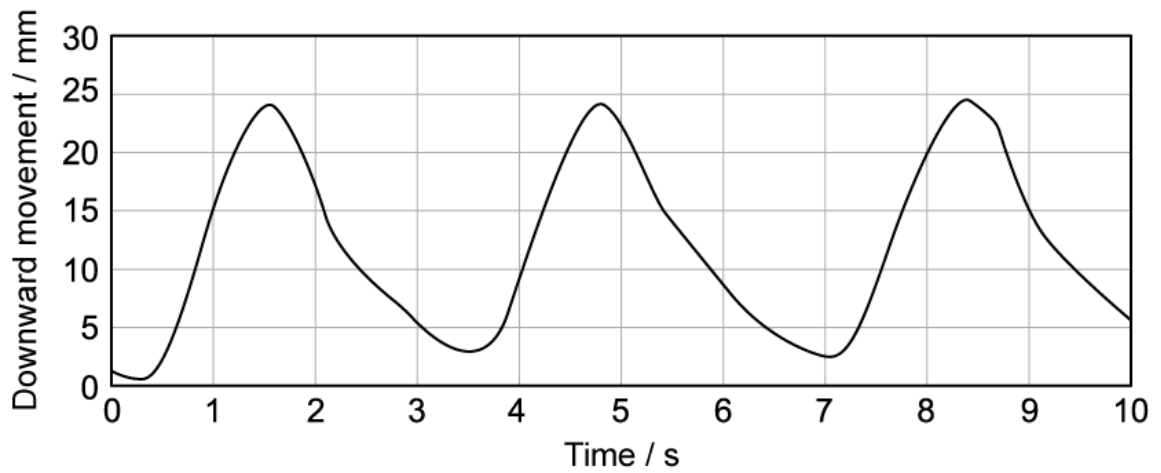
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(3 marks)

(c) The graph below shows the results of another participant in the study. This individual is a 57-year-old male with emphysema.



(i) Contrast the graph shown here with the graph in part a).

[2]

(ii) Suggest an explanation for the differences between the graphs.

[2]

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**(4 marks)**

**(d)** Events such as surgical trauma or nerve degeneration can lead to weakness or even paralysis of the diaphragm.

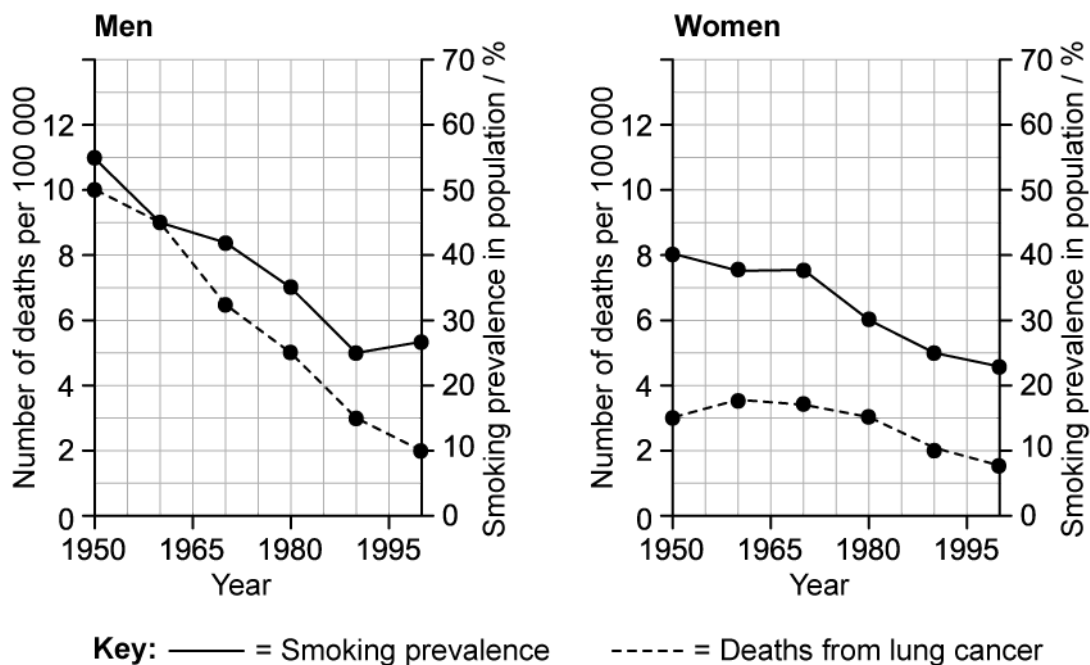
Suggest the effect that this would have on ventilation.

.....

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**(2 marks)**

3 (a) The graphs below show smoking prevalence and lung cancer deaths in men and women in the UK between 1950 - 2000.



Calculate the percentage decrease in smoking prevalence between 1950 - 1990 for:

(i) Men

[1]

(ii) Women

[1]

(2 marks)

(b) Compare and contrast the **trends** in smoking prevalence and lung cancer deaths between men and women in the graphs shown in part a).

**(3 marks)**

- (c)** A student looked at the graphs in part a) and concluded that cigarette smoking causes lung cancer.

Evaluate this conclusion from the graphs shown.

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**(3 marks)**

- (d)** Data from other studies provide support for the student's conclusion in part c) and scientists now accept that smoking can cause lung cancer.

Explain the link between smoking and lung cancer.

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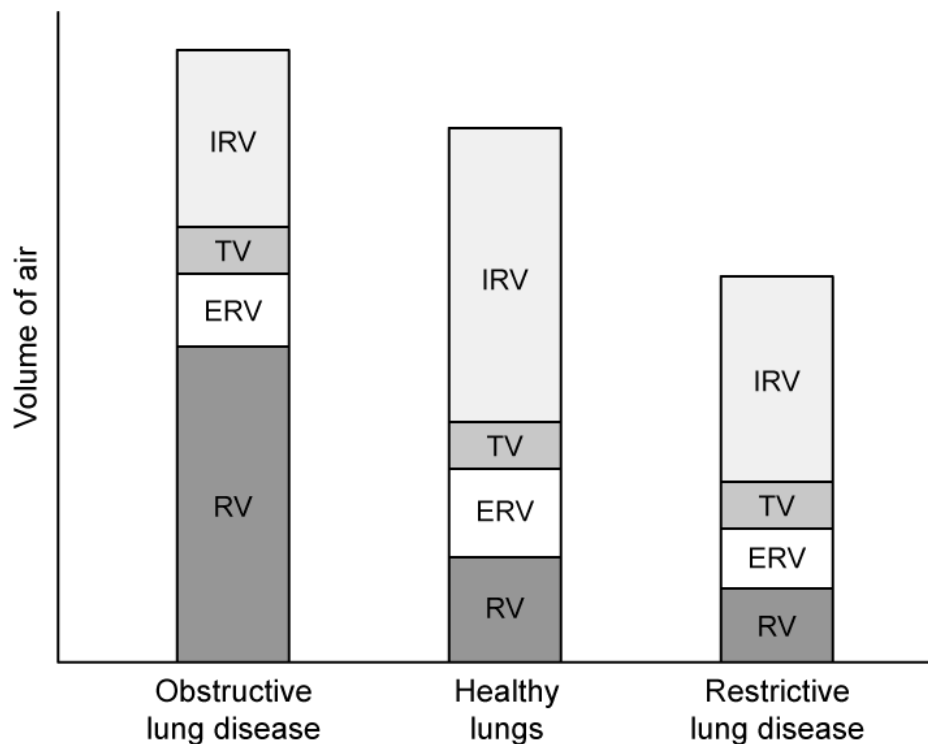
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**(3 marks)**

4 (a) Certain types of lung disease can be categorised as either obstructive or restrictive. The effect of obstructive and restrictive lung diseases on ventilation can be seen in the graph below, where:

- Tidal volume (TV) = the volume of air breathed in and out with each normal breath
- Inspiratory reserve volume (IRV) = the additional volume of air that can be drawn into the lungs during a large inward breath
- Expiratory reserve volume (ERV) = the additional volume of air that can be expelled from the lungs during forced expiration
- Residual volume (RV) = the volume of air that remains in the lungs after forced expiration



Compare and contrast the effects of obstructive and restrictive lung disease.

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(3 marks)

**(b)** An example of an obstructive lung disease is emphysema.

Suggest how emphysema causes the features of an obstructive lung disease shown in the graph in part a).

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.....

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**(3 marks)**

**(c)** Explain why sufferers of both obstructive and restrictive lung disease find exercise difficult.

.....

.....

.....

**(3 marks)**

**(d)** Use the graph in part a) to suggest what might be happening to the lungs in a restrictive lung disease.

.....

.....

**(2 marks)**

**5 (a)** *One mark is available for clarity of communication throughout this question.*

Outline the need for a ventilation system in mammals.

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**(3 marks)**

**(b)** Draw an annotated diagram to explain the process of inspiration.

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**(6 marks)**

**(c)** Explain how the lungs are adapted to their function.

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**(6 marks)**