Exchange Surfaces

Model Answers 3

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Exchange and transport
Topic	Exchange Surfaces
Booklet	Model Answers 3

Time allowed: **65 minutes**

Score: **/48**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

Fig. 1.1 shows an air sac and a capillary in the mammalian lung.

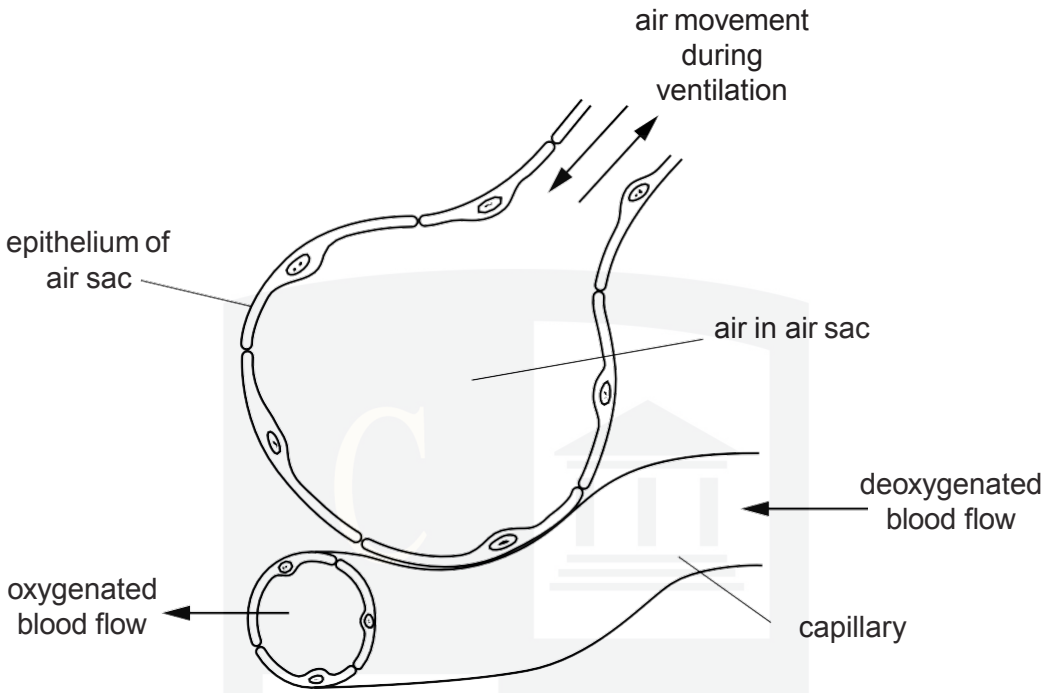


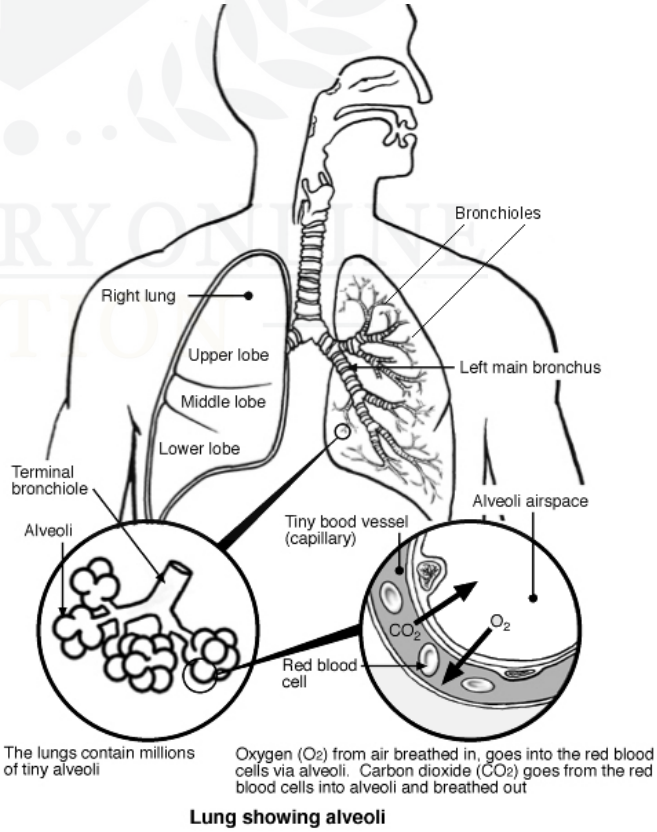
Fig. 1.1

(a) The mammalian lungs contain many air sacs.

(i) Name the air sacs **and** state why there are many air sacs in the lungs. **[2]**

- The air sacs in the lungs are named **alveoli**
- There are many alveoli in the lungs in order to **increase surface area**.

Diagram to show the human thorax, with alveoli in the lungs to increase the surface area for gas exchange:

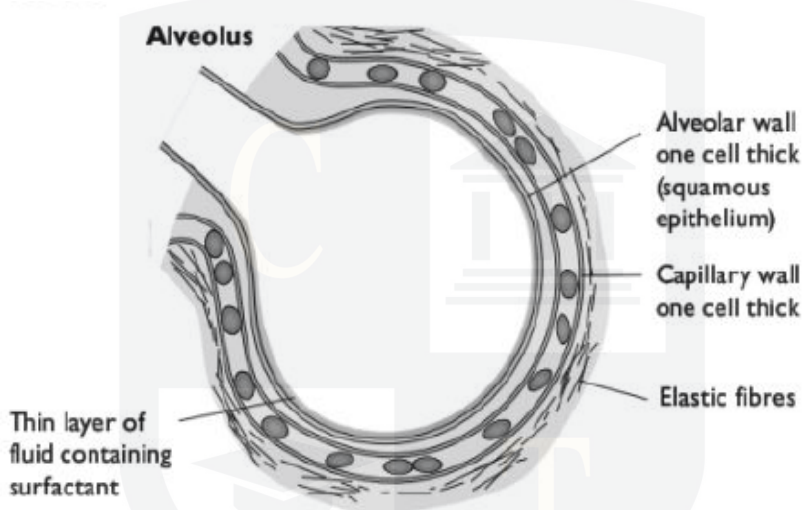


Lung showing alveoli

(ii) Name the type of epithelium in the walls of the air sacs. **[1]**

The type of epithelium in the walls of the air sacs is **squamous epithelium**

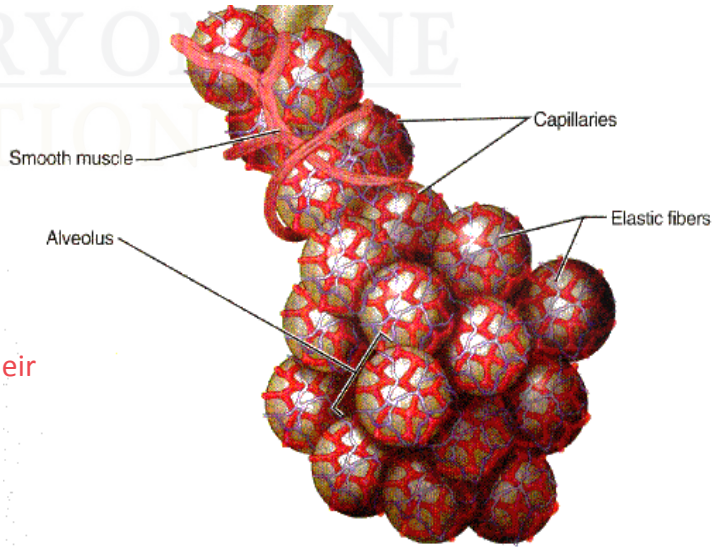
Diagram to show one alveolus with squamous epithelial cells, to ensure diffusion distance is small:



(iii) The air sacs contain many elastic fibres.

Explain the role of these elastic fibres during ventilation. **[2]**

Diagram to show the location of elastic fibres in the alveoli:



- The elastic fibres prevent **bursting** when the alveoli fill up with air
- They help **expel air**
- The elastic fibres provide **recoil**
- so that the alveoli return to their **original size and shape**

(b) For efficient gaseous exchange to occur, a steep diffusion gradient must be maintained between the air in the air sacs and the blood.

A steep diffusion gradient can be maintained by ventilating the lungs. This refreshes the air in the air sacs.

(i) Explain how refreshing the air in the air sacs helps to maintain a steep diffusion gradient.

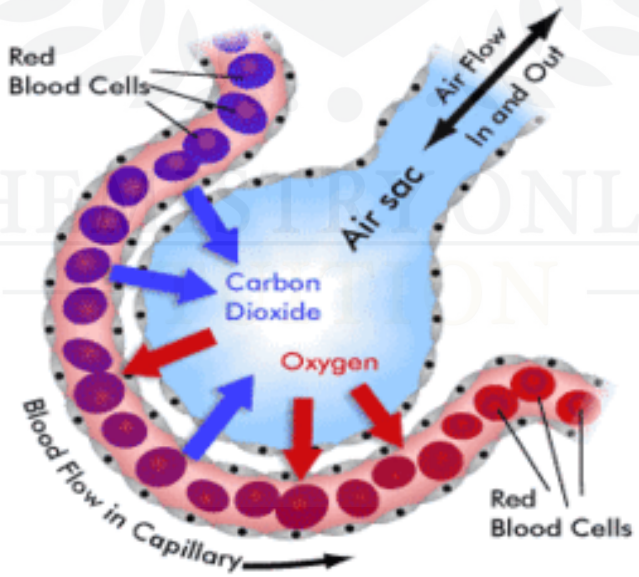
[2]

Refreshing the air maintains a steep concentration gradient because:

- It increases the partial pressure of oxygen in the air sac
- So the concentration of oxygen in the air sac is higher than that in the blood
- It also decreases the partial pressure of carbon dioxide in air sac
- So that the concentration of CO_2 in the air sac is lower than that in the blood

A high concentration can be seen when there is a concentration difference of a substance one side of the membrane to the other.

A diagram to show the gas exchange between the alveoli and the blood:



(ii) Describe **and** explain **one other** way in which a steep diffusion gradient is maintained in the lungs. **[2]**

One other way that a steep diffusion gradient is maintained in the lungs is:

- By the **continuous flow of blood in capillaries** to the alveoli in the lungs
- This results in **more oxygen being taken away** from the lungs and **more carbon dioxide being brought** to the lungs

OR

- Oxygen combines with haemoglobin in the red blood cells
- This keeps it out of solution in the plasma (and hence the concentration low)

***Exam tip**: here you must ensure that you give both the way in which a concentration gradient is maintained and explain how that maintains the gradient.*

[Total: 9]

Question 2

Fig. 5.1 shows a spirometer, which is used to investigate lung function.

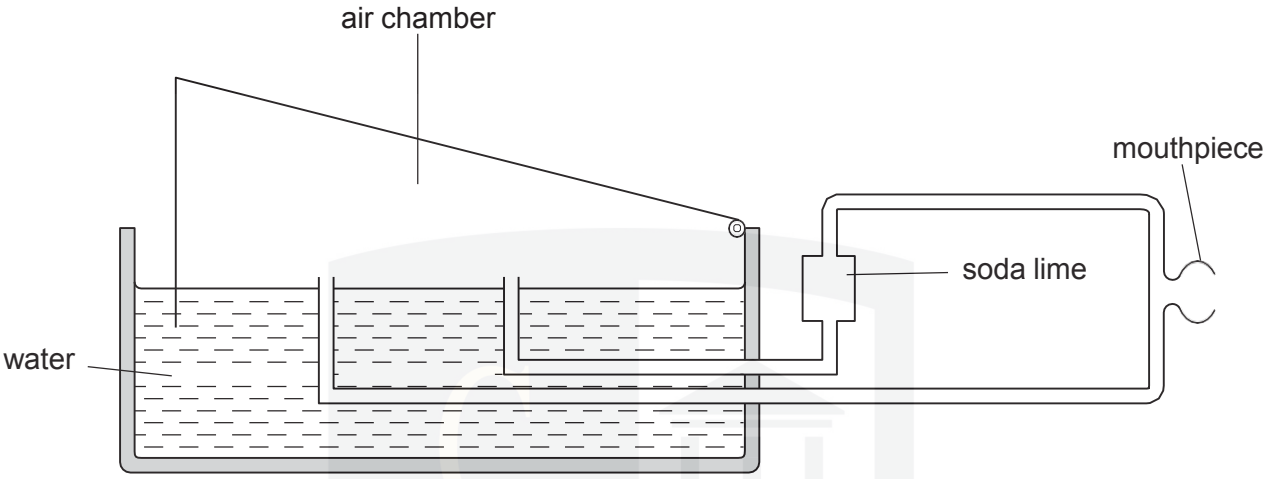


Fig. 5.1

(a) (i) Describe how the spirometer would be used to measure tidal volume. **[3]**

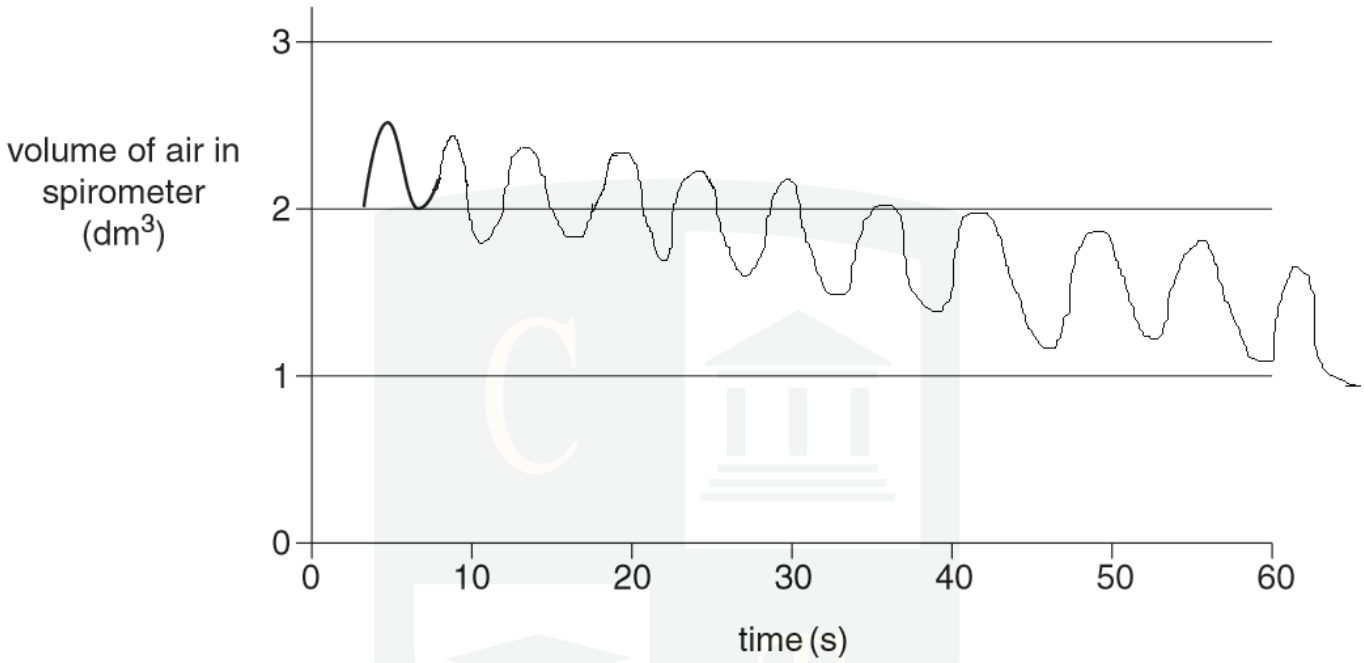
A spirometer can be used to measure tidal volume by:

- The subject wears a nose clip so that they do not breathing through their nose
- The subject breathes normally
- As they breathe in the lid goes down and as they breathe out lid goes up (creating a trace)
- Measure the height (amplitude) of waves from the trace
- Measure at least three waves and calculate a mean

Tidal volume is the volume of air taken in and out of the lungs during one normal breath.

Therefore the spirometer can measure this by creating a trace.

(ii) Using the axes below, complete the spirometer trace that you expect to see recorded from a healthy sixteen year old over **ten further breaths**, while at rest. **[2]**



The diagrams should show 10 further waves drawn with similar heights. Also, over time the trace falls. This is because the oxygen component of the air is being taken into the body of the test subject and used for respiration.

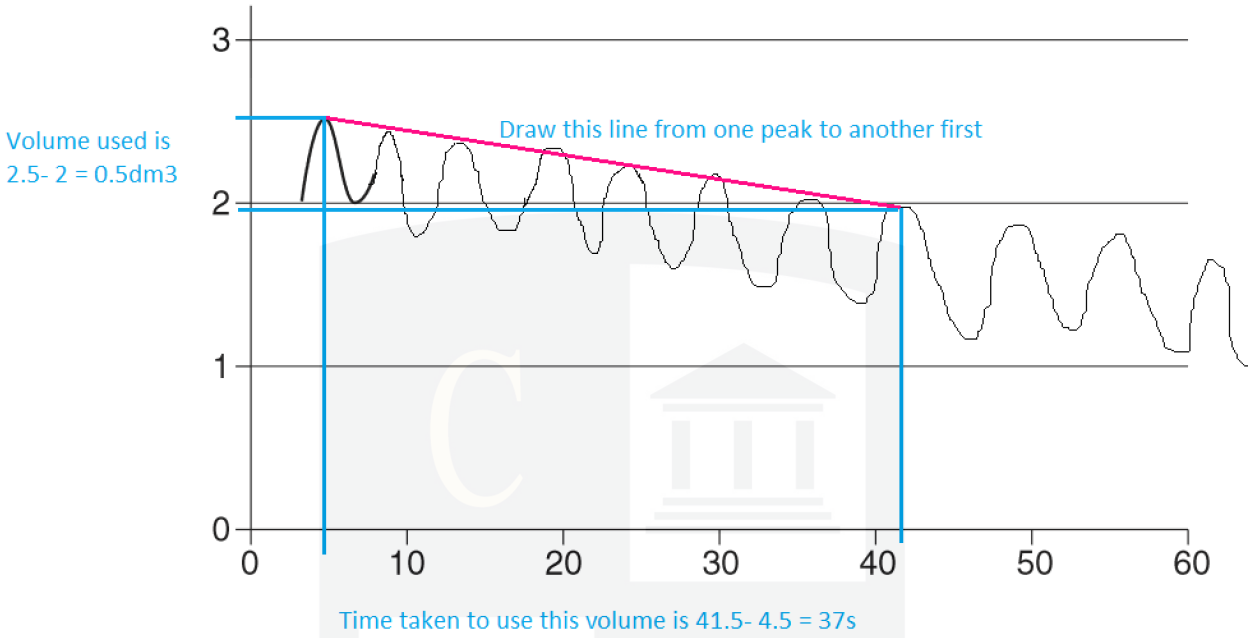
(iii) Describe how you could use a spirometer trace to measure the rate of oxygen uptake. **[3]**

You could use the trace to measure oxygen uptake by:

Measure the decrease in volume in the air chamber

- The difference in volume can be measured by **drawing lines across the tips of the peaks of the trace**
- Then you need to **measure the time taken** to use this volume of oxygen
- **Divide the volume by time taken** to use the oxygen to get the rate of oxygen uptake

For example, using the trace above:



Therefore rate is 0.5/37 = **0.0135dm^3/s** (they may want it per minute, so you might have to convert s to min)

(b) Suggest **two** factors that should be considered when carrying out a risk assessment for an experiment using a spirometer.

[2]

Two factors to be considered when doing a risk assessment for a spirometer should be (any two of):

- check health of volunteer
- oxygen used
- Sterilised mouthpiece for each volunteer
- soda lime is working
- sufficient oxygen in chamber
- water level not too high (water must not enter tubes)
- ensure valves working correctly

[Total: 10]

Question 3

Fig. 6.1 is a diagram of a spirometer, a piece of apparatus used to measure some aspects of breathing, such as breathing rate and vital capacity.

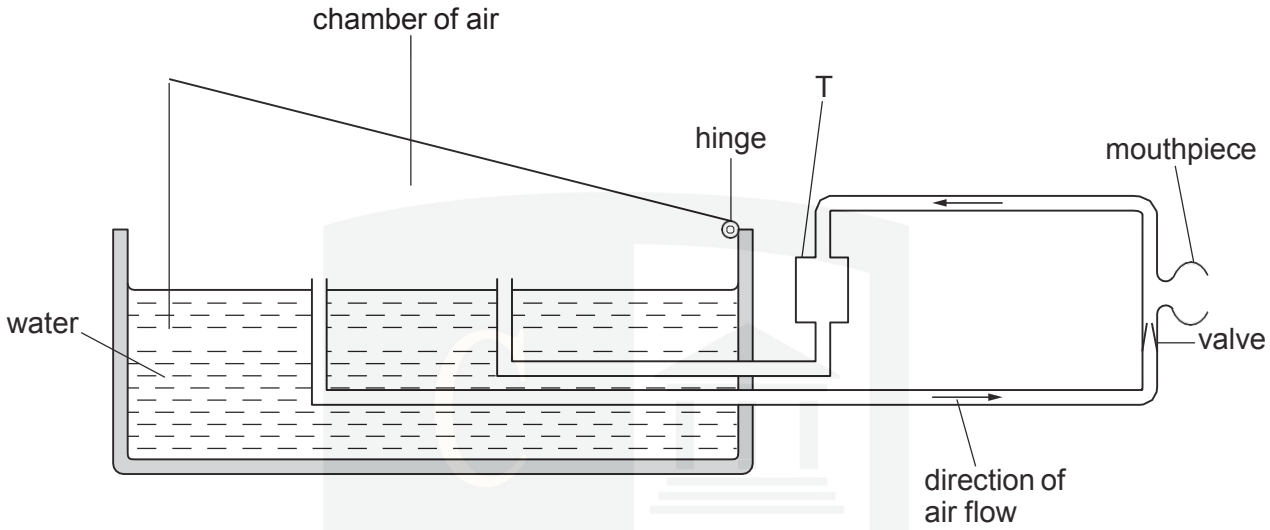


Fig. 6.1

(a) (i) Outline the mechanism of **inspiration**.

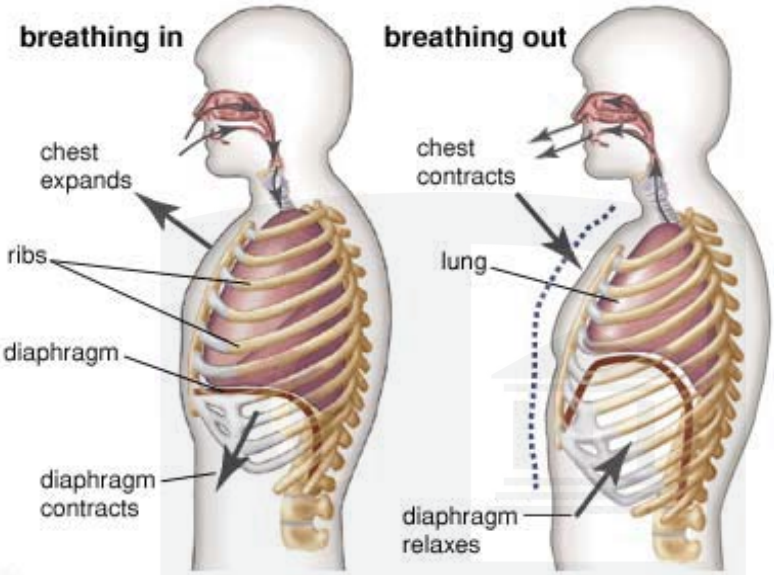
In your answer you should use appropriate technical terms, spelt correctly. **[3]**

Inspiration is achieved by:

- the **diaphragm** and **intercostal** muscles contracting
- causing the **diaphragm** to move down and the ribs to move upwards and outwards.
- This increases the **volume** of the **thorax**
- causing the **pressure** inside the thorax to fall
- to below atmospheric **pressure**, resulting in air entering the lungs

*Note: inspiration is the mechanism of breathing **in**. Remember: to gain your QWC mark, you need to include the key words shown here in **bold**.*

Diagram to show the mechanism of breathing:



(ii) A person breathes through the mouthpiece of a spirometer.

State what happens to the air chamber in Fig. 6.1 during **inspiration**. **[1]**

During inspiration:

- The chamber **goes down**

This is because the person is drawing the air put of the chamber and using it to fill their lungs.

(iii) Chamber **T** contains a chemical that absorbs carbon dioxide.

Suggest a chemical that could be used in chamber **T** to absorb carbon dioxide. **[1]**

A chemical used to absorb carbon dioxide is:

- **Soda lime/ sodium hydroxide/potassium hydroxide/calcium hydroxide**

(b) Explain why a person using the spirometer to measure their vital capacity should wear a noseclip. **[2]**

The person must wear a nose clip to:

- To prevent the entry/escape of air from the nose.
- To ensure that all the air breathed in comes from the chamber.
- This would make the results **invalid**.

(c) State **two** other precautions that should be taken when using a spirometer to measure vital capacity.

[2]

Other precautions that should be taken are (two of):

- Medical grade oxygen or fresh air should be used
- The mouthpiece should be disinfected for each user
- The health of the subject should be assessed before use
- The equipment should be checked for correct functioning before use (eg, checking for leaks)

[Total: 9]

Question 4

Fig. 1.1 (a) is a diagram of a part of a mammalian lung.

Fig. 1.1 (b) is an enlargement of part of the lining of the bronchus.

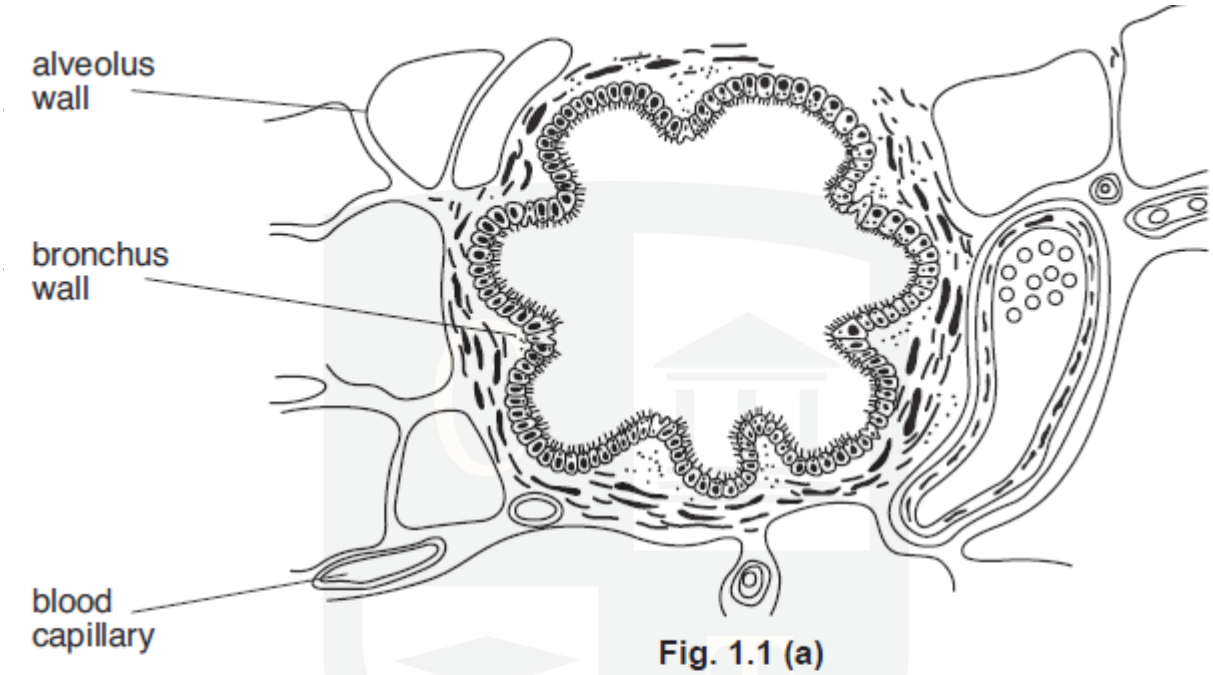


Fig. 1.1 (a)

Fig. 1.1 (b)

(a) (i) Name the two types of cell, **A** and **B**, shown lining the **bronchus**. **[2]**

A Goblet cell

Can be identified by its **goblet-like** shape

B Ciliated epithelium

Can be identified by the **row of cilia (hairs)** along the top.

(ii) Describe how cell types **A** and **B** work together to keep the lung surface clear of dust and other particles.

[3]

- Goblet cells release **mucus**
- which **traps** particles and pathogens
- and the ciliated epithelial cells **waft** the **mucus** containing the particles
- to the top of the trachea

(iii) The bronchus wall also contains smooth muscle fibres.

State the function of the smooth muscle fibres. **[1]**

The function of the smooth muscle fibres is:

- to constrict the **bronchus**

(b) (i) Explain why blood capillaries and alveoli are very close together. **[2]**

Blood capillaries and alveoli are close together:

- to create a **short** diffusion **distance**
- so that the **concentration gradient** is high
- for a high rate of **gas exchange**

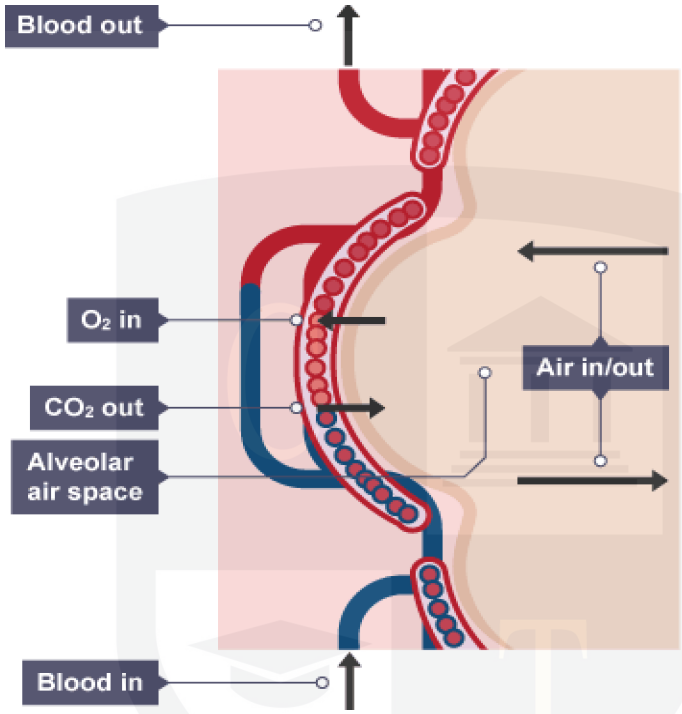
(ii) The walls of the alveoli contain elastic fibres.

State the function of these elastic fibres. **[1]**

The elastic fibres in the walls of the alveoli:

- ensure that they **expel the air** in them

Diagram to show the structure of the alveolus and the site of gas exchange:



[Total: 9]

Question 5

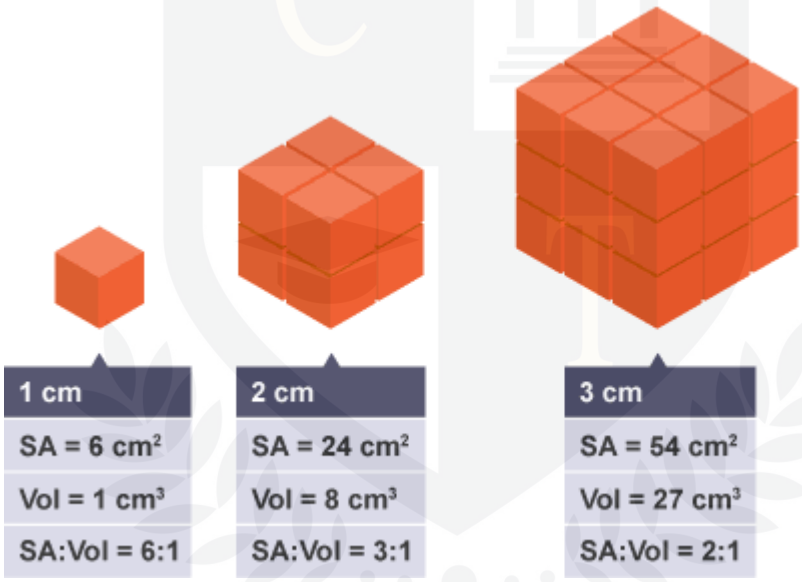
(a) Explain, using the term **surface area to volume ratio**, why large, active organisms need a specialised surface for gaseous exchange.

[2]

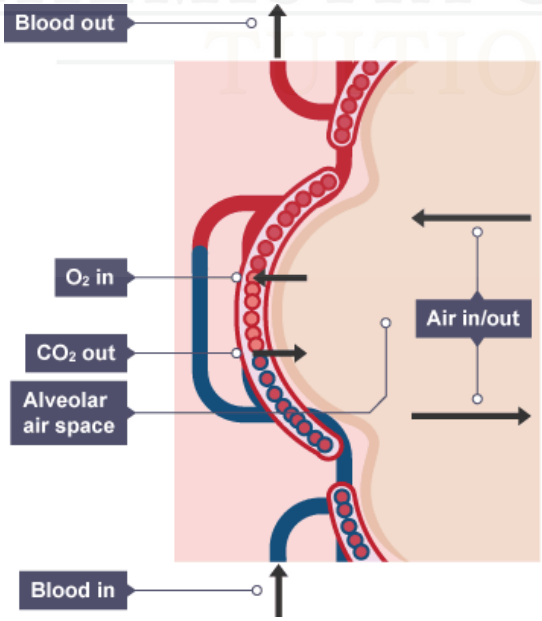
Active organisms need a specialised gas exchange system because:

- they have a higher demand for oxygen
- they are generally larger, so have a small **surface area to volume ratio**
- Therefore, diffusion of respiratory gases would take too long because large organisms have a high demand for oxygen

Diagram to show the relationship between size and surface area to volume ratio:



A diagram to show the site of gas exchange:



(b) Table 4.1 describes some of the features of the mammalian gas exchange system.

Complete the table by explaining how each feature improves the efficiency of gaseous exchange. The first one has been completed for you.

[3]

Table 4.1

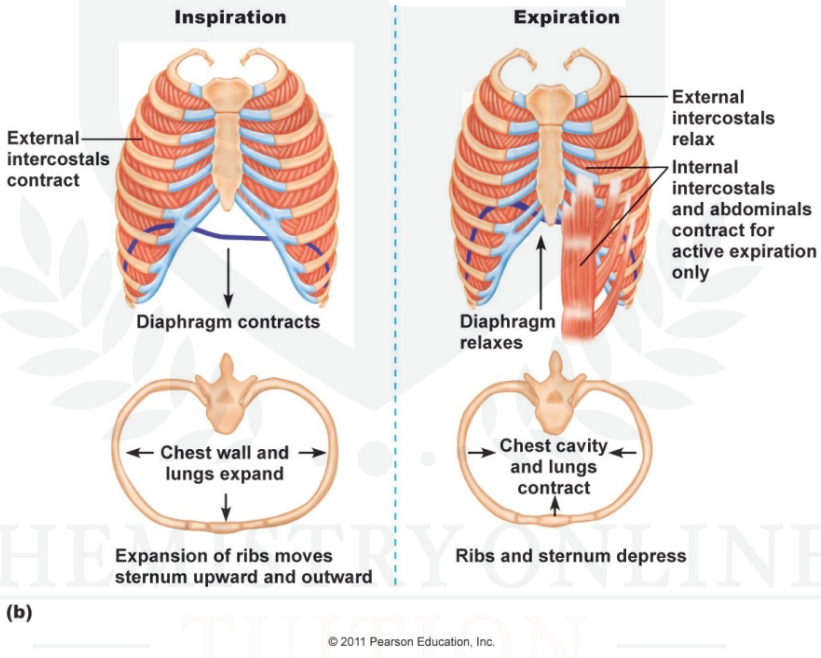
feature of gas exchange system	how feature improves efficiency of gaseous exchange
many alveoli	this increases the surface across which oxygen and carbon dioxide can diffuse
the epithelium of the alveoli is very thin	short distance for diffusion
there are capillaries running over the surface of the alveoli	Delivers carbon dioxide/ removes oxygen short distance for diffusion The capillaries take the excess carbon dioxide to the lungs to be removed from the body
the lungs are surrounded by the diaphragm and intercostal muscles	For ventilation Maintains a diffusion gradient The steeper the gradient, the quicker the rate of diffusion

(c) Outline how the diaphragm **and** intercostal muscles cause **inspiration**. **[4]**

Inspiration occurs by:

- diaphragm contracts and moves downwards
- intercostal muscles contract to move ribs up and out
- this increases the volume of the thorax
- which in turn reduces the pressure inside the thorax
- to below atmospheric pressure, creating pressure gradient

Diagram to show the processes of inspiration and expiration:



(d) Fig. 4.1 shows the trace from a spirometer recorded from a 16-year-old student.

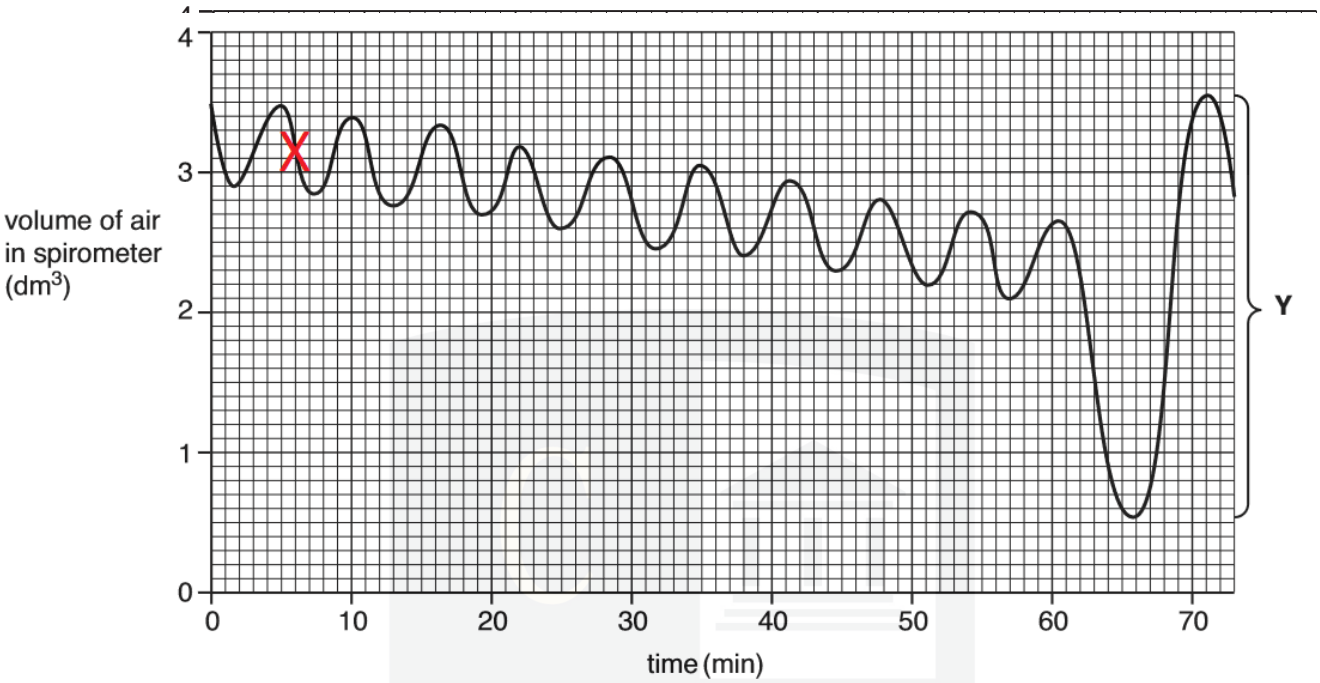


Fig. 4.1

(i) **Label on the trace**, using the letter **X**, a point that indicates when the student was inhaling. **[1]**

X is drawn where line goes down, because volume in the spirometer decreases as the air has entered the lungs.

(ii) At the end of the trace the student measured his vital capacity. This is indicated by the letter **Y**.

State the vital capacity of the student. **[1]**

The Vital Capacity (Y) is:

- $3dm^3$

Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inhalation.

[Total: 11]