Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL – NEW

2400U20-1

S17-2400U20-1

BIOLOGY – AS unit 2
Biodiversity and Physiology of Body Systems

TUESDAY, 6 JUNE 2017 – AFTERNOON

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**11**	
3.	**10**	
4.	**13**	
5.	**15**	
6.	**12**	
7.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended repsonse (QER) will take place in question **7**.

The quality of written communication will affect the awarding of marks.

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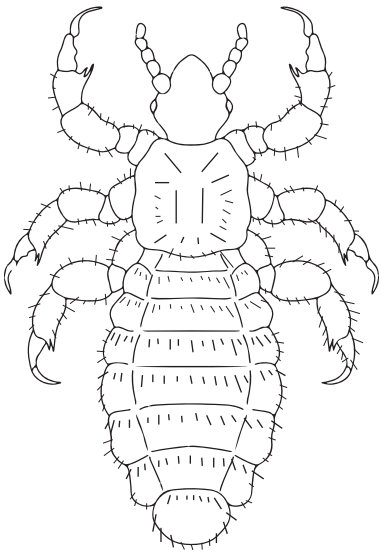
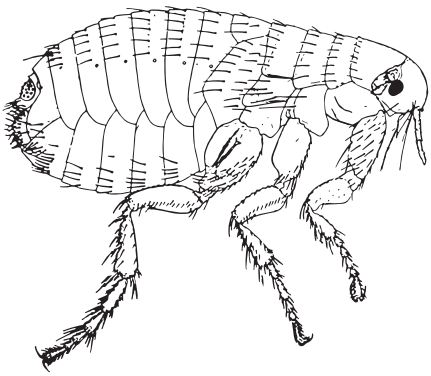
Answer **all** *questions.*

1. *(a)* The following diagrams show the external features of two insects. Both are human ectoparasites.



Head louse *(Pediculus humanus)*



Flea *(Pulex irritans)*

(i) Define the term ectoparasite. [2]

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(ii) Unlike fleas, head lice normally infest a new host only by close contact between individuals. Suggest **one** reason why this is the case. [1]

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(iii) State why these insect species are classified in the same domain and kingdom as humans *(Homo sapiens)*. [2]

Domain .....

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Kingdom .....

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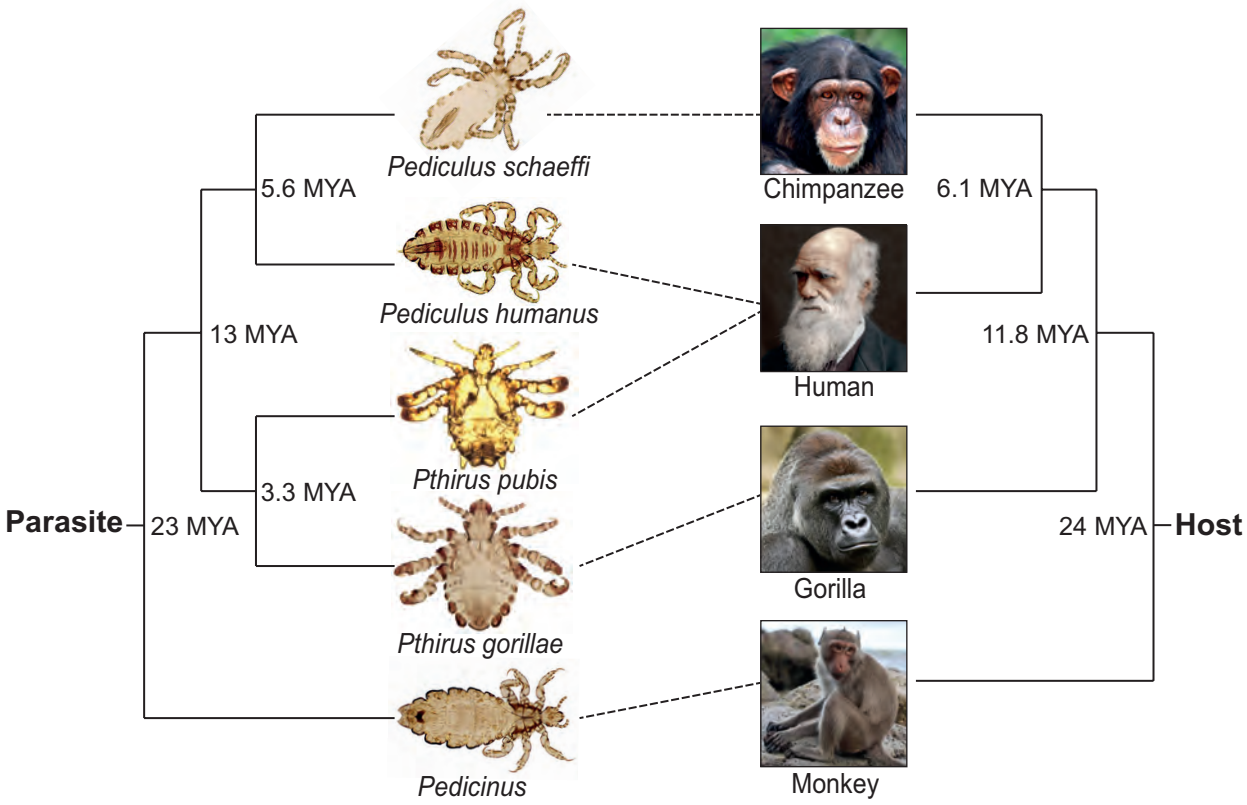
(b) The diagram below shows phylogenetic trees illustrating the coevolution of different species of lice and their vertebrate hosts. The dotted lines represent parasite-host relationships. The numbers at branch nodes on each tree represent the estimated time of divergence from a common ancestor in millions of years ago (MYA). These times were obtained using a molecular clock supported by fossil evidence. A molecular clock measures the degree of genetic similarity between species.



(i) Describe the evidence that suggests that the common ancestor of gorillas and humans was **not** infested with the pubic louse, *Pthirus pubis*. [2]

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(ii) Suggest how DNA analysis could be used to measure the degree of genetic similarity between species. [1]

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(iii) The table below represents a hypothetical molecular clock.
Insert the value for the time of divergence for 90% genetic similarity **in the table below**. [1]

Degree of genetic similarity / %	**Time of divergence from a common ancestor / MYA**
40	30
60	20
80	10
90	.....

(c) Another human ectoparasite is the disease-carrying body louse. The body louse attaches its eggs to clothing whereas the head louse attaches its eggs to scalp hair. Suggest why they are considered to be the same species. [1]

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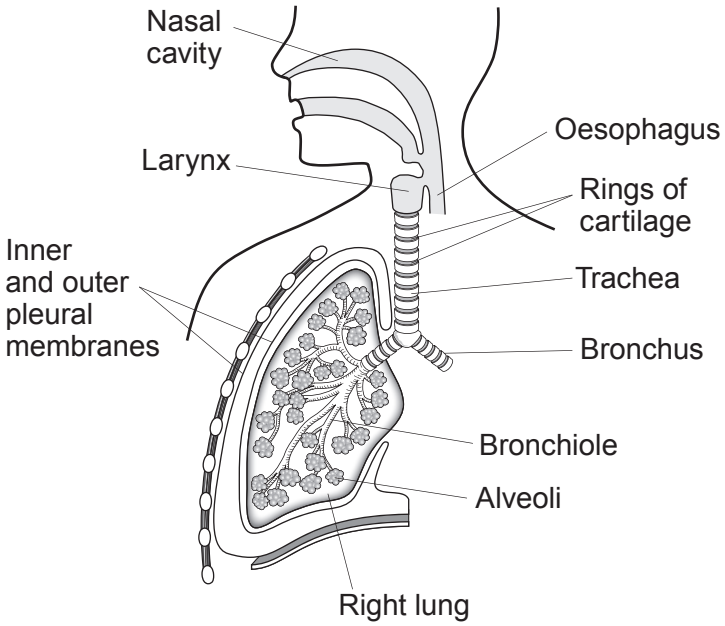
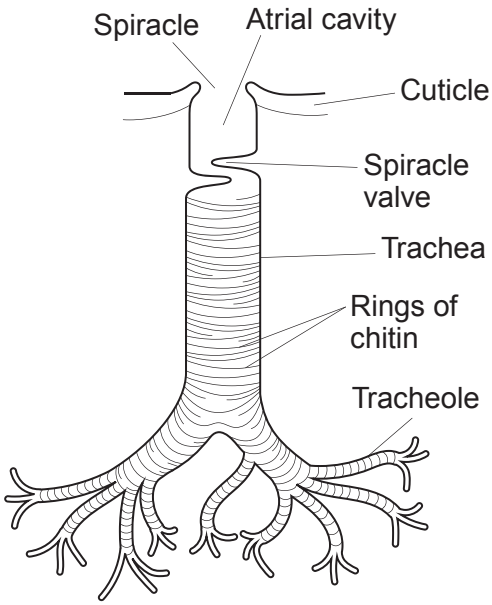
2. The diagrams below show parts of the human and insect respiratory systems.





Diagrams not to scale

(a) These systems have a number of features in common. Complete the table below to explain the purpose of these features. [4]

Feature	Explanation
Both systems are internal	
The nasal cavity and the atrial cavity contain hairs	
The walls of alveoli and tracheoles are one cell thick	
Alveoli and tracheoles are lined with a surfactant	

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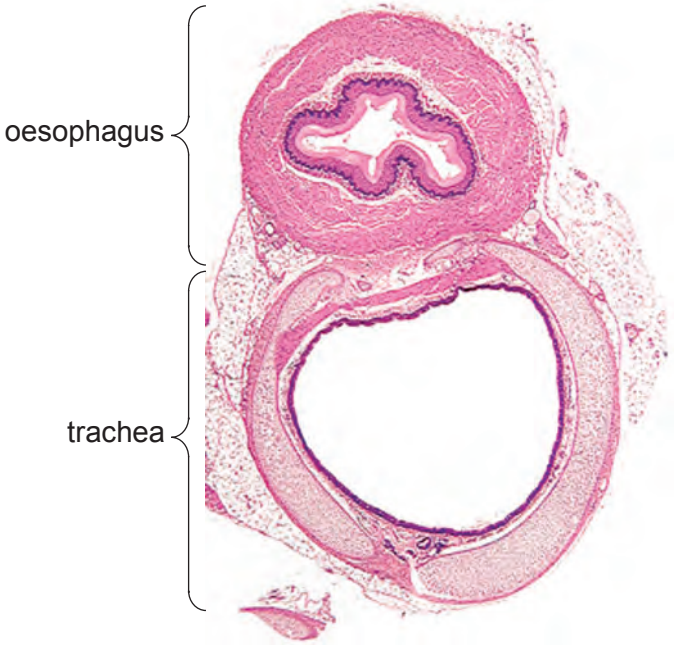
(b) The photomicrograph below is a cross section through the trachea and oesophagus of a mammal.



(i) The rings of chitin in an insect's trachea are complete. The rings of cartilage in a mammal's trachea are incomplete or "C-shaped". Use the information in the photomicrograph to suggest why the rings of cartilage in a mammal's trachea are incomplete. [1]

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(ii) Name **one** plant tissue that shows a similar pattern of support material to that seen in an insect's tracheae. [1]

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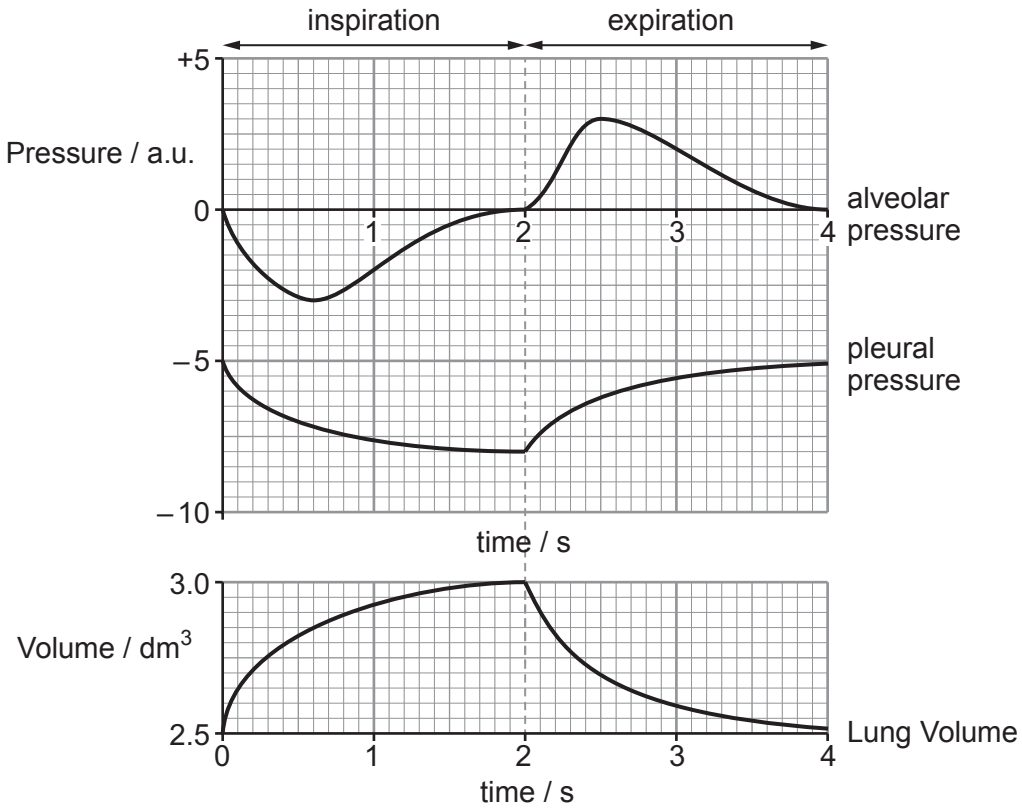
(c) The graph below shows the pressure and volume changes during a single ventilation cycle of a healthy human at rest.



(i) During inspiration the external intercostal muscles contract raising the rib cage. This causes the outer pleural membrane to move outwards. Using the graphs, explain the causes of the pressure and volume changes shown during inspiration. [4]

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(ii) Suggest **one** change that you would expect to see in these curves during strenuous exercise. [1]

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3. *(a)* Some insects are vectors of plant diseases. Two such diseases are Dutch elm disease and potato leafroll.

Elm bark beetles are vectors of Dutch elm disease. These beetles are often contaminated with fungal spores. When the beetles feed on the young bark of healthy elm trees the fungal spores gain entry to xylem vessels. The spores germinate and produce a mycelium which leads to the blockage of xylem vessels. The earliest external symptoms of infection are chlorosis (yellowing) and wilting of leaves above the infection site. These leaves often turn brown and curl up. Symptoms often spread rapidly leading to the death of the tree.

Potato leafroll is caused by a virus carried by aphids. When aphids feed, the virus enters the phloem. The virus infects cells in the leaves and the roots. Symptoms include chlorosis and rolling of leaves, and death of potato tuber cells.

(i) Explain why blockage of xylem vessels by the fungus causes the wilting of leaves above the infection site and the death of elm trees. [4]

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(ii) Explain the difference in the distribution of the symptoms of potato leafroll in a plant compared to those seen in Dutch elm disease. [2]

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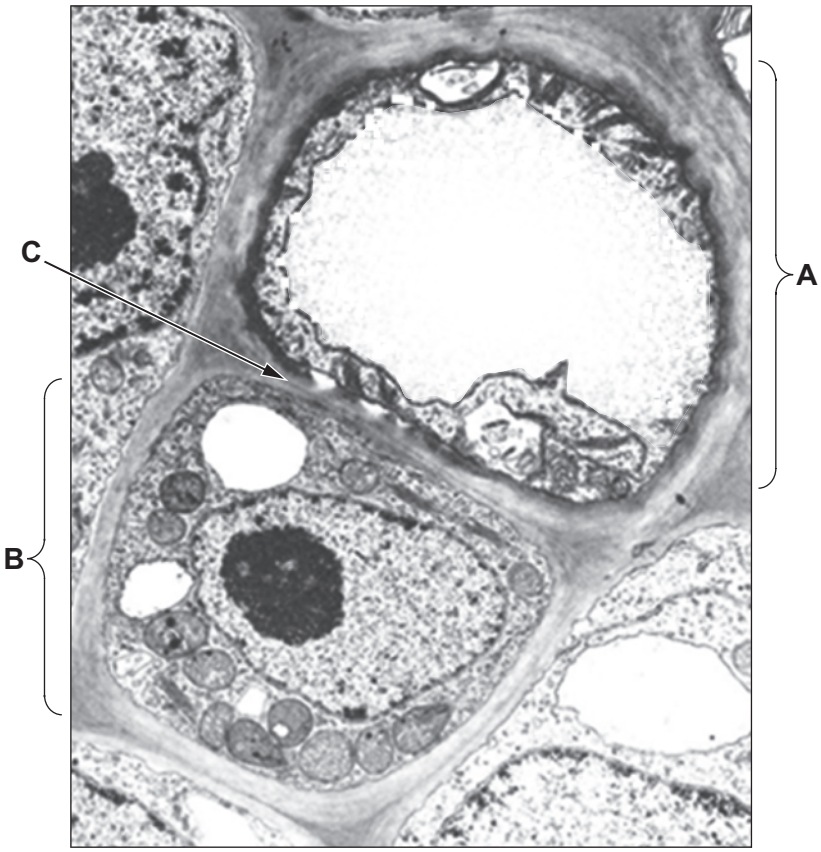
(b) The photomicrograph below is a transverse section of phloem tissue taken using a transmission electron microscope.



(i) Identify the cells labelled **A** and **B**. [1]

A .....

B .....

(ii) Give **one** reason for your choice of answer to *(b)*(i). [1]

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(iii) The photomicrograph below is of region **C** at a higher magnification. It shows the adjoining cell walls of **A** and **B**.

Identify structures **D** and explain their importance in the functioning of phloem. [2]

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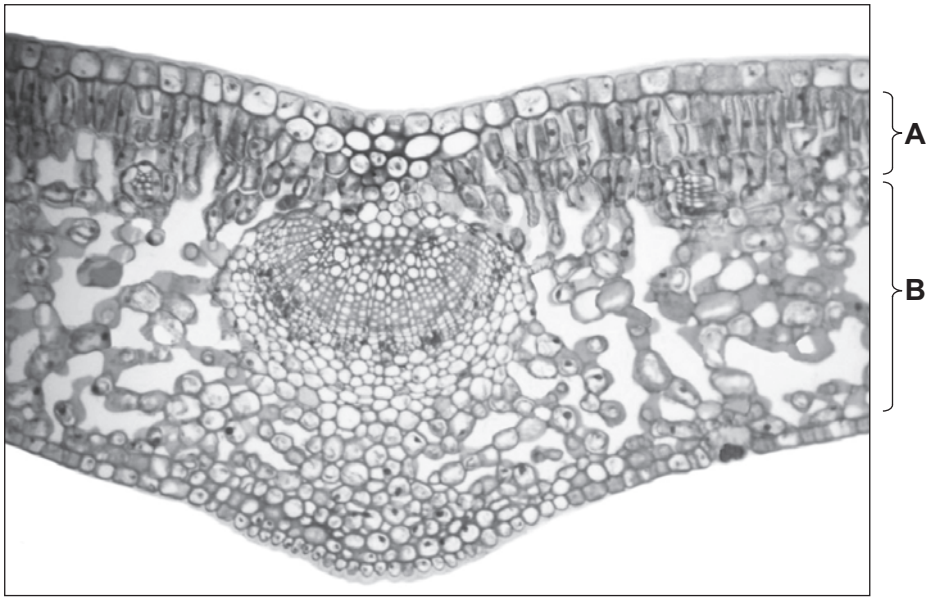
4. *(a)* The photomicrograph below is of a transverse section through a privet *(Ligustrum)* leaf in the region of the midrib.



Complete the table below to name the tissues labelled **A** and **B**. For each tissue describe how it is adapted for its role in photosynthesis. [4]

	Name of tissue	**Adaptation of tissue for photosynthesis**
A		
B		

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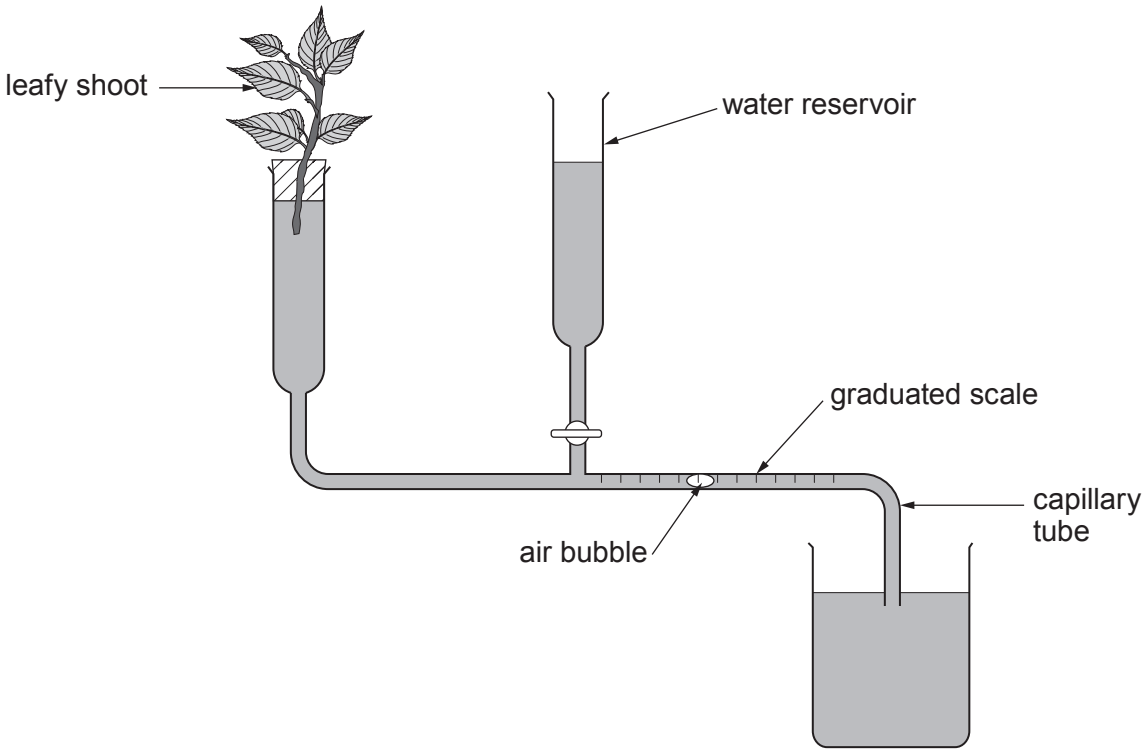
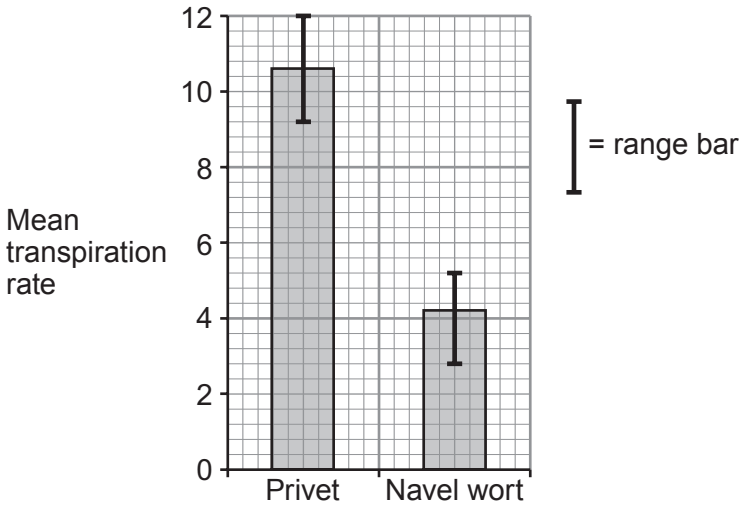
(b) The diagram below shows a potometer. This apparatus is used to measure the rate of transpiration.



A student carried out an investigation to compare the transpiration rates of two plants: privet *(Ligustrum)* which is a mesophyte and navelwort *(Umbilicus)* which is a xerophyte. She measured the time taken for the air bubble to travel a distance of 50 mm along the capillary tube and used this to calculate the volume of water lost per minute. Five trials were performed for each plant. Finally she measured the total surface area of the leaves in cm^2 and calculated the transpiration rates of each plant per unit area. She presented her results in the following bar chart.



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(i) During the investigation the temperature was maintained constant at 20 °C. Name **two** other environmental factors that should have been kept constant during the investigation. [2]

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(ii) Which unit should have been included on the bar chart to represent the mean transpiration rate? [1]

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(iii) The student concluded that the transpiration rates of the two plants were significantly different. Use the information in the bar chart to explain why she was confident in reaching this conclusion. [1]

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(iv) Suggest **one** structural adaptation of navelwort and explain how it could account for the difference in transpiration rates of privet and navelwort. [2]

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(v) The student found that the scale on the capillary tube was accurate to ±1.0 mm. She measured the time taken for the air bubble to travel a distance of 50 mm along the capillary tube. Calculate the percentage error of the equipment over this distance. Show your working in the space below. [2]

Percentage error = ± ..... %

(vi) Using the same apparatus, suggest **one** way in which the accuracy of the measurement could be improved other than by using a capillary tube with smaller graduations. [1]

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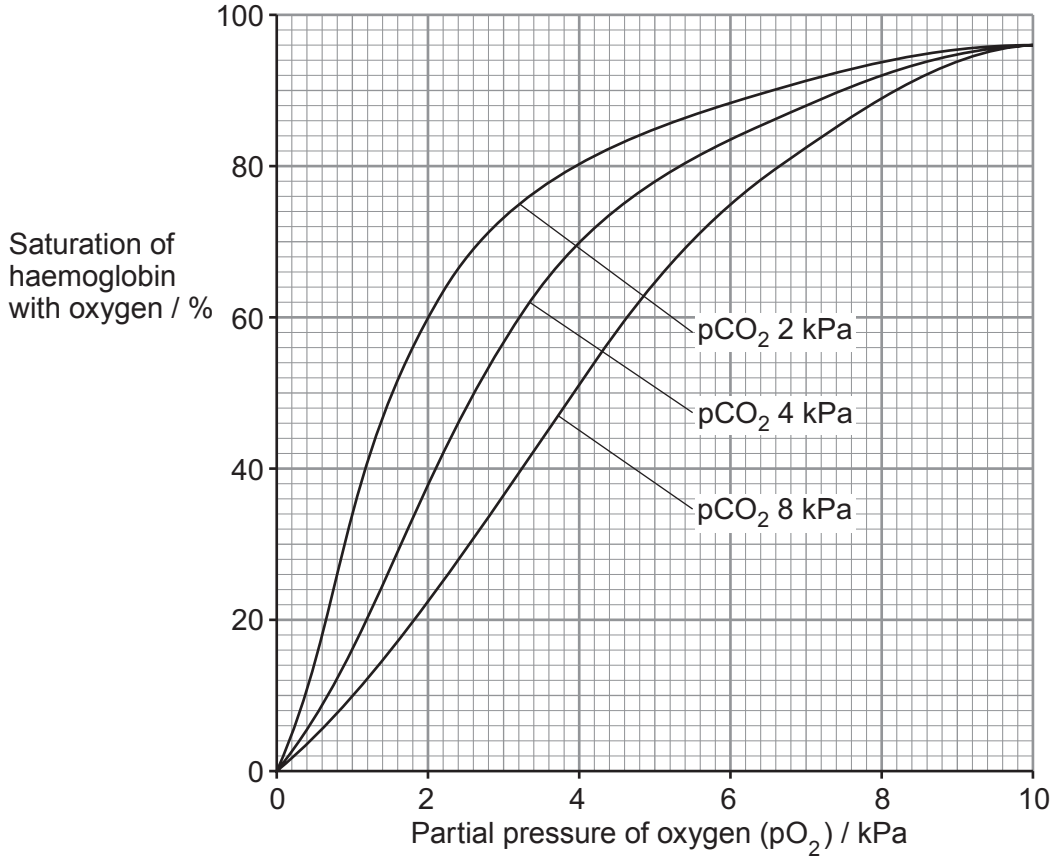
5. Carbon dioxide is produced in tissues as a waste product of respiration. The graph shows the effect of increasing the partial pressure of carbon dioxide (pCO_2) on the oxygen dissociation curve of adult human haemoglobin.



(a) State the name given to the difference in position between the three curves as a result of an increase in the partial pressure of carbon dioxide. [1]

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(b) The table shows the partial pressures of oxygen (pO_2) and carbon dioxide (pCO_2) at different sites in the human body.

Site	pO_2 / kPa	pCO_2 / kPa
lungs	10	2
muscle tissue fluid at rest	4	4
muscle tissue fluid during exercise	1	8

(i) The graph shows that at the pO_2 and pCO_2 typical in the lungs the percentage saturation of haemoglobin with oxygen is 96 %. Give the percentage saturation of haemoglobin with oxygen in muscle tissue fluid when it is: [2]

at rest ..... %

during exercise ..... %

(ii) Explain the significance of the effect of an increase in pCO_2 for respiring muscle tissue. [2]

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(c) Respiratory minute volume is the volume of gas inhaled or exhaled from a person's lungs per minute. The minute volume of a healthy person during normal breathing at rest is 6 – 7 dm^3min^{-1}. In people with chronic diseases, such as heart disease, the minute volume is 12 – 16 dm^3min^{-1}.

(i) Explain how an increase in minute volume results in a decrease in pCO_2 of blood in alveolar capillaries. [2]

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(ii) Suggest why people with reduced blood pCO_2 commonly feel tired and lack energy. [2]

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(d) Most carbon dioxide is carried as hydrogen carbonate ions (HCO_3^-) in the plasma. The following chemical pathway shows how carbon dioxide is converted into HCO_3^- in a red blood cell.

$$CO_2 + H_2O \xrightarrow{\mathbf{X}} \mathbf{Y} \longrightarrow \mathbf{Z} + HCO_3^-$$

(i) Identify the substances shown above: [2]

X .....

Y .....

Z .....

(ii) State **one** *other* form in which carbon dioxide is carried in the blood. [1]

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(iii) The table shows the concentrations of hydrogen carbonate ions and chloride ions in the blood plasma of an arteriole entering and a venule leaving a respiring muscle.

Blood vessel	**Plasma concentration / mmol dm^{-3}**	
	Hydrogen carbonate ions	**Chloride ions**
Arteriole	22	106
Venule	30	98

Explain the changes in the concentration of chloride ions as shown by the table above. [3]

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6. Pepsin and trypsin are enzymes involved in the digestion of proteins in the alimentary canals of mammals. Both enzymes are endopeptidases.

A group of students performed an experiment to investigate the effect of an endopeptidase, an exopeptidase and a mixture of the two enzymes on the digestion of protein in milk powder. As the protein is digested the solution becomes clear.

Equal volumes and concentrations of the enzyme solutions were added to equal volumes and concentrations of milk powder solution. The pH was maintained using a pH 8 buffer solution. The time taken for the solution to become clear was recorded, as shown below.

Student group	**Time taken for milk solution to become clear / s**		
	Endopeptidase	**Exopeptidase**	**Mixture of endopeptidase and exopeptidase**
A	43	74	19
B	77	95	39
C	69	93	34
D	88	138	34
E	52	69	36
F	47	71	34
G	109	198	60
H	61	80	42
I	83	166	26
J	38	60	15
Mean for all groups	.....	104	34

(a) Calculate the mean time for the milk solution to become clear when mixed with the endopeptidase. **Insert your answer in the table above**. [2]

(b) The results show a great deal of variation. However, it was decided that there were no anomalous results. Explain why this decision was made. [1]

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(c) Suggest **two** sources of inaccuracy within the experimental method, which could account for the variation in the results of the groups. For each of your suggestions give **one** way in which the method could be improved. [4]

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(d) Explain why digestion was more rapid when using the enzyme mixture than when using the individual enzymes. [3]

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(e) Explain why pepsin was **not** the endopeptidase chosen for use in this investigation. [2]

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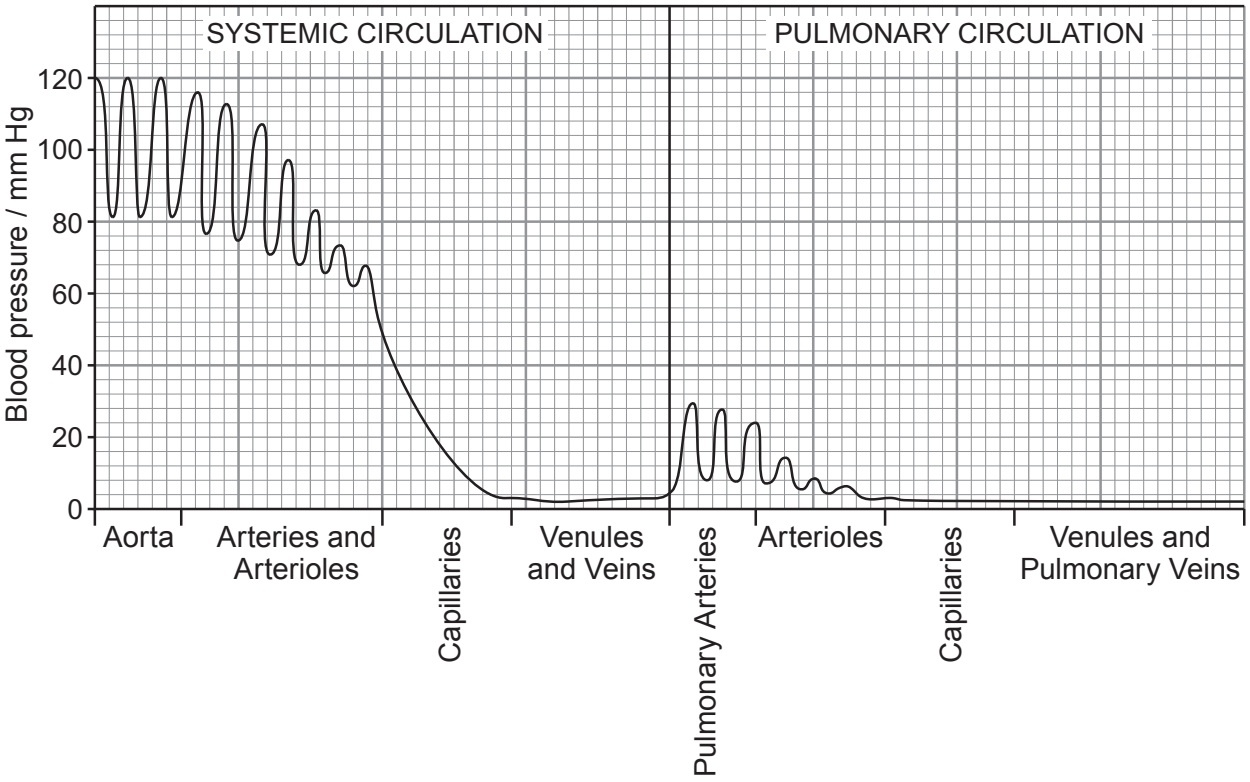
7. Mammals have a double circulatory system, whereas fish have a single circulatory system. The graph illustrates pressure changes in the double circulation of a human.



Use the information in the graph to explain the pressure changes in the systemic and pulmonary circulations of a human.
Explain why a mammal's double circulation is considered more efficient than the single circulation of a fish. [9 QER]

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