PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



EXAM QUESTION PACK

TOPIC 4: EXCHANGE AND TRANSPORT

GAS EXCHANGE

SCORE	PERCENTAGE
/92	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions and mark schemes in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question or mark scheme material in this pack. Pearson has not endorsed, approved or been involved in the production of it. Pearson, Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

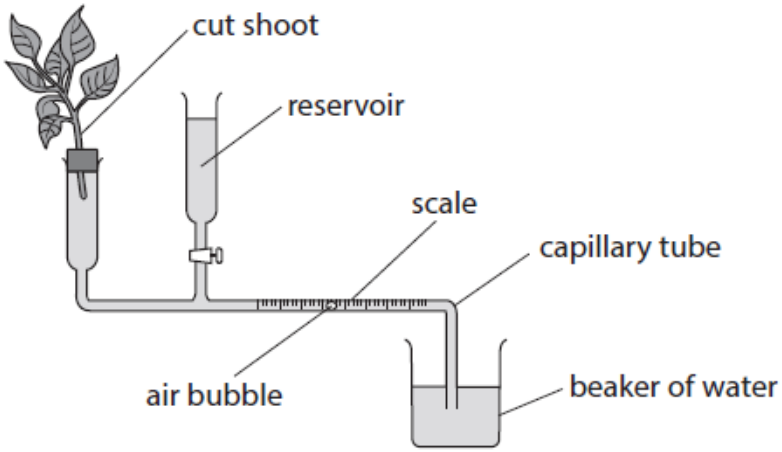
Pearson publishes its past papers and mark schemes free of charge. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

Water moves through xylem vessels in a plant during transpiration.

A student used the potometer shown in the diagram to investigate the rate of water uptake in a leafy shoot.



The student investigated the effect of a combination of environmental conditions on the rate of water uptake.

The table shows the results of this investigation.

Conditions	Distance moved by the bubble in 5 minutes / cm					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean
Still air, in light	2.4	2.2	2.2	2.2	2.1	2.2
Moving air, in light	6.5	6.7	6.4	6.2	6.3	6.4
Still air, in dark	0.9	0.4	0.0	0.0	0.0	0.3
Moving air, in dark	1.7	0.8	0.0	0.0	0.0	0.5

(i) The internal diameter of the capillary tubing is 0.3 mm.

The volume of a cylinder is calculated using the formula

$$\pi r^2 h$$

Calculate the mean rate of water uptake for the shoot in moving air, in the light.

Give your answer in $mm^3\ min^{-1}$ to two significant figures.

(3)

Answer ..... $mm^3\ min^{-1}$

(ii) Analyse the data to explain the results of this investigation.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(iii) Describe how this investigation could be modified to make a valid comparison of water loss from the upper and lower surfaces of the leaves.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 10 marks)

Q2.

* Acute respiratory distress syndrome (ARDS) is a condition that can occur in babies.

In ARDS, cells in the alveoli do not produce enough of a substance called surfactant.

The alveoli cannot expand sufficiently when the baby inhales.

The diagram shows the alveoli of a baby with ARDS and the alveoli of an unaffected baby.



Alveoli of a baby with ARDS



Alveoli of an unaffected baby

Scientists investigated the effect of two synthetic surfactants, A and B, for treating ARDS.

Four groups of rabbits with ARDS were used.

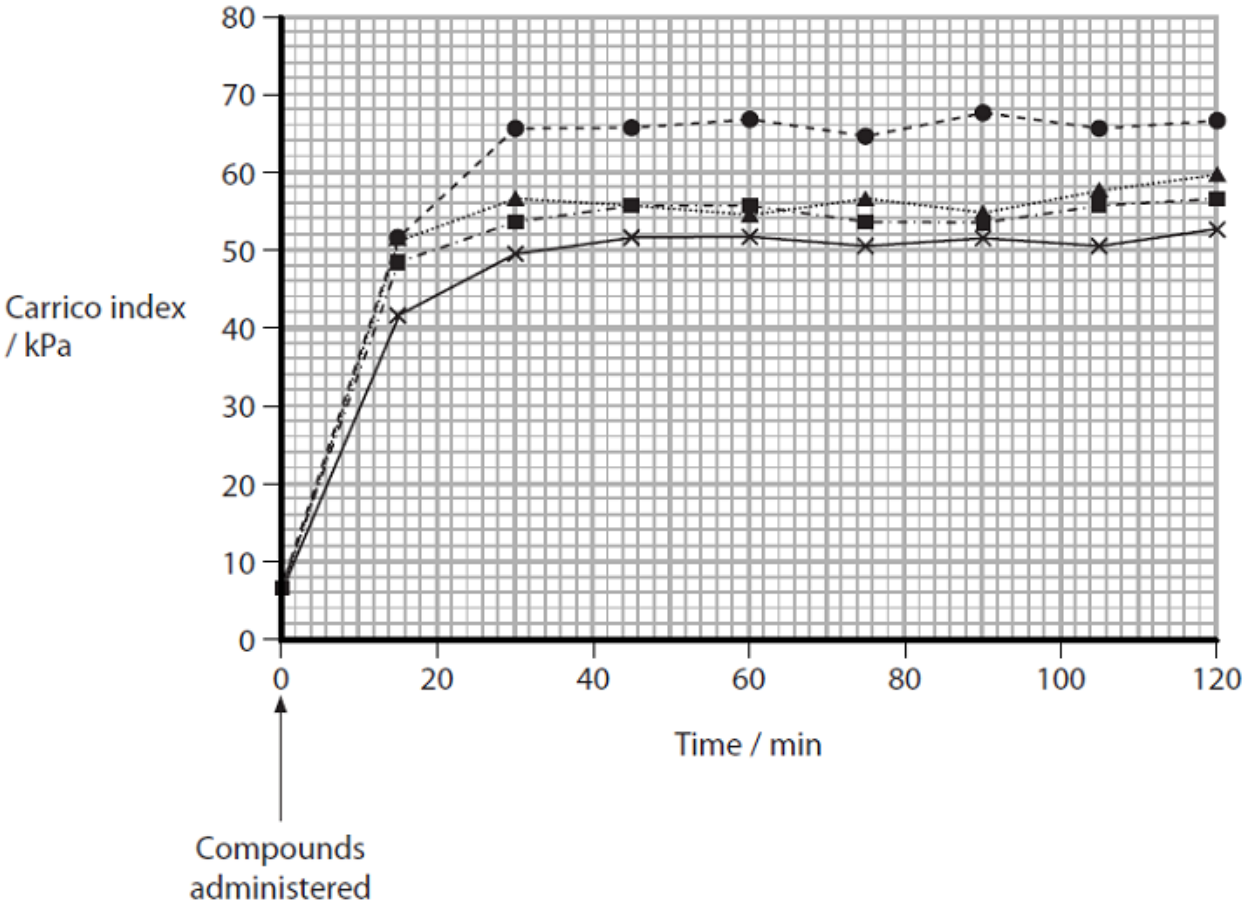
Each group of rabbits was given a different treatment.

- One group received compound A.
- One group received compound B.
- One group received both compound A and compound B.
- One group received a natural surfactant control.

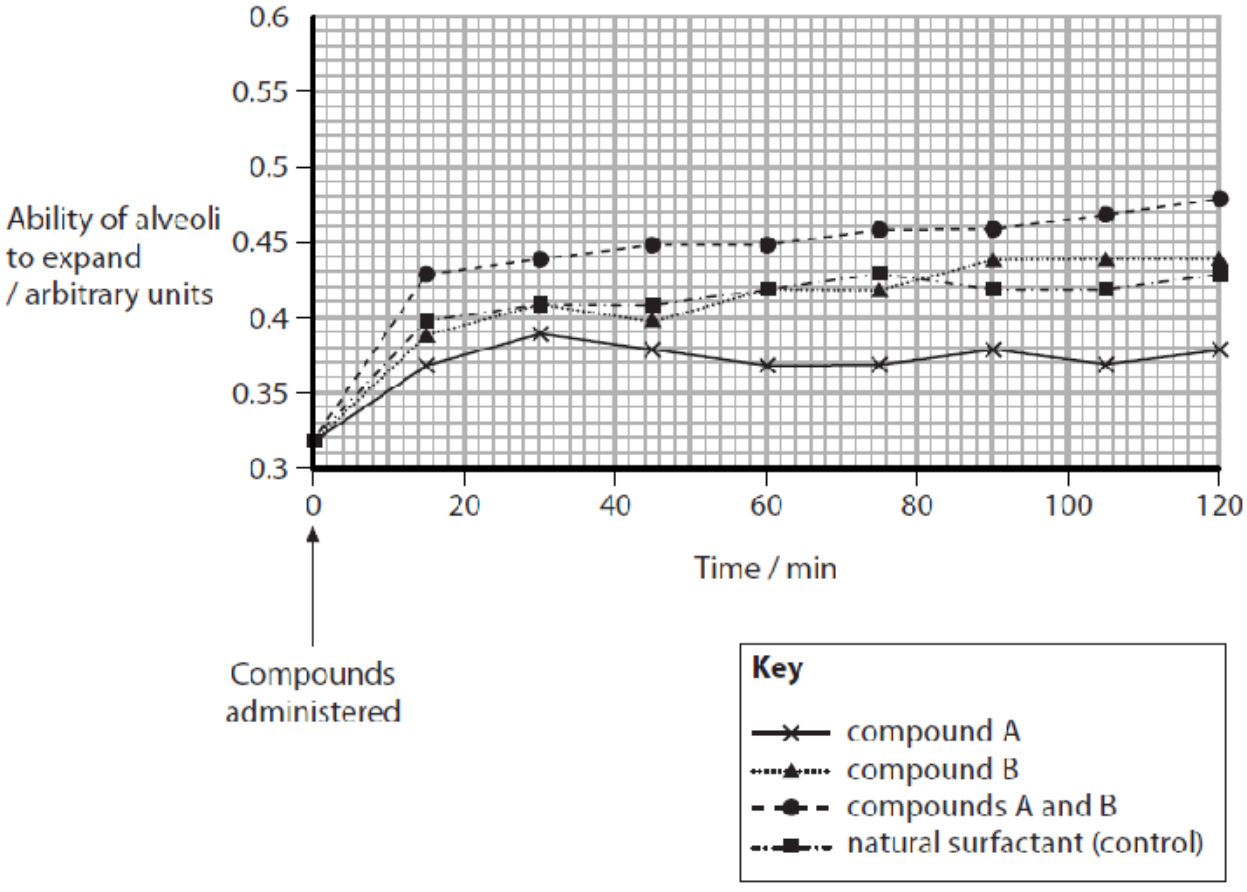
The mean Carrico index of each group of rabbits and the ability of the alveoli to expand were determined every 15 minutes.

Graph 1 and Graph 2 show the results of this investigation.

Graph 1 Effect of compounds A and B on the Carrico index



Graph 2 Effect of compounds on the ability of alveoli to expand



Analyse the data to explain the potential use of these two compounds to treat ARDS in human babies.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q3.

Acute respiratory distress syndrome (ARDS) is a condition that can occur in babies.

In ARDS, cells in the alveoli do not produce enough of a substance called surfactant.

The alveoli cannot expand sufficiently when the baby inhales.

The diagram shows the alveoli of a baby with ARDS and the alveoli of an unaffected baby.



Alveoli of a baby with ARDS



Alveoli of an unaffected baby

The efficiency of the lungs is calculated using the formula for the Carrico index.

$$\text{Carrico index} = \frac{\text{partial pressure of oxygen in arterial blood}}{\text{proportion of oxygen in inhaled air}}$$

The table shows the Carrico index for an unaffected baby and a baby with ARDS.

Baby	Carrico index / kPa
Unaffected baby	67
Baby with ARDS	38

(i) Calculate the partial pressure of oxygen in arterial blood for the unaffected baby, if the proportion of oxygen in inhaled air is 0.21.

(1)

Answer ..... kPa

(ii) Explain why the Carrico index for the baby with ARDS is lower than the Carrico index for the unaffected baby.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

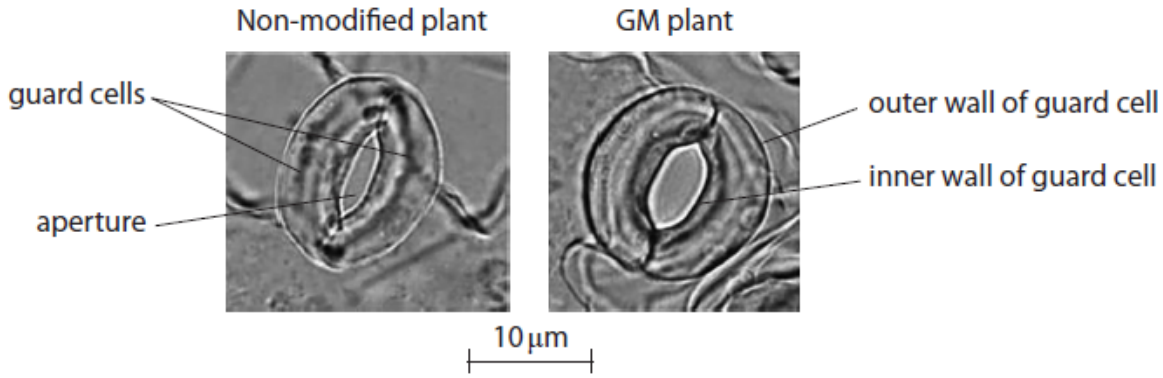
Q4.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Genetically modified (GM) crop plants have been produced that have stomata with a wider aperture than non-modified crop plants.

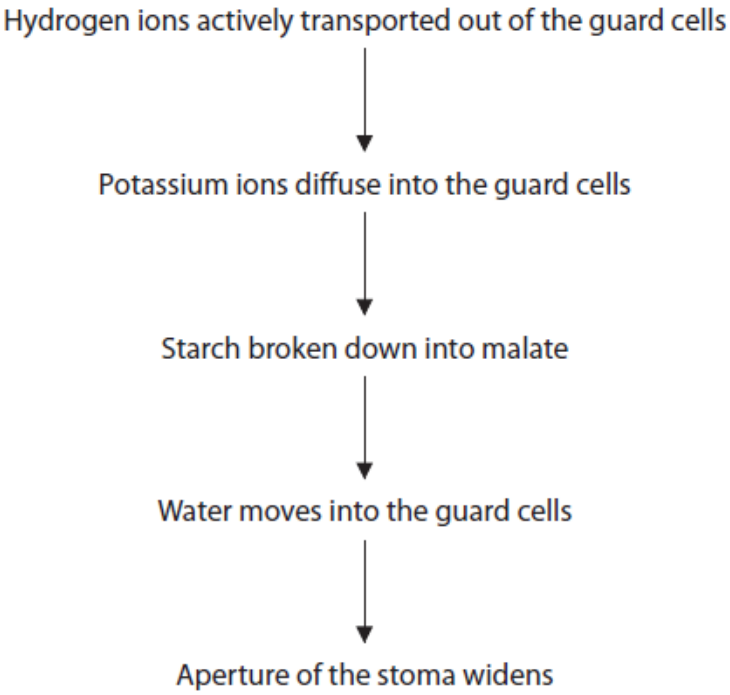
This difference in the width of the aperture is only evident in daylight.

The photographs show the appearance of each type of stoma in daylight.



Sourced from: http://www.aip.nagoya-u.ac.jp/en/public/nu_research/images/Wang_f1.jpg

The flow chart shows some of the steps involved in opening the aperture of a stoma.



(i) What happens when hydrogen ions are actively transported out of the guard cells?

(1)

☒ **A** ADP and phosphate ions are converted into ATP by a hydrolysis reaction

☒ **B** ADP and phosphate ions are converted into ATP by a condensation reaction

☒ **C** ATP is broken down into ADP and phosphate ions by a condensation reaction

☒ **D** ATP is broken down into ADP and phosphate ions by a hydrolysis reaction

(ii) Which of the following explains why water moves into the guard cells?

(1)

☒ **A** malate lowers the water potential of the cytoplasm

☒ **B** malate raises the water potential of the cytoplasm

☒ **C** starch lowers the water potential of the cytoplasm

☒ **D** starch raises the water potential of the cytoplasm

(iii) Which of the following explains why the aperture of the stoma widens?

(1)

☒ **A** The guard cells become smaller and the inner wall of the guard cell is more flexible than the outer wall

☒ **B** The guard cells become smaller and the inner wall of the guard cell is less flexible than the outer wall

☒ **C** The guard cells become larger and the inner wall of the guard cell is more flexible than the outer wall

☒ **D** The guard cells become larger and the inner wall of the guard cell is less flexible than the outer wall

(Total for question = 3 marks)

Q5.

A student planned to keep two species of fish in an aquarium.

One species of fish should be kept at a minimum temperature of 25 °C. The other species requires a minimum concentration of oxygen of 7.5 mg dm^{-3} water.

Explain why the student chose to keep these two species of fish in an aquarium at 30 °C.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

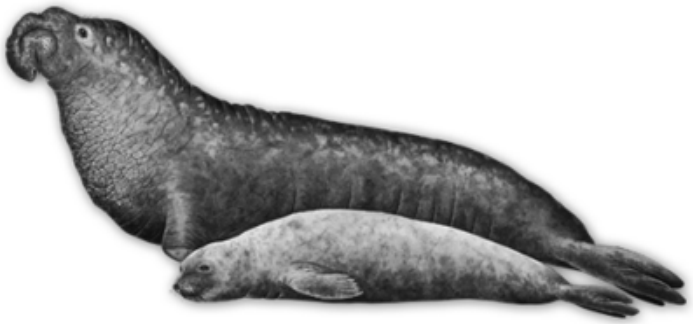
.....

.....

(Total for question = 4 marks)

Q6.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

Species	Maximum time holding breath / min	Maximum diving depth / m	Mass of animal / kg
bottlenose dolphin	5	20	200
harbour seal	17	19	24
Weddell seal	82	400	400
Northern elephant seal	119	437	400

Species	Volume of oxygen in body / $cm^3\ kg^{-1}$	Concentration of haemoglobin in blood / $g\ dm^{-3}$	Total blood volume / $cm^3\ kg^{-1}$	Percentage of stored oxygen in different body tissues		
				lungs	blood	muscle
bottlenose dolphin	36	14	71	34	27	39
harbour seal	57	21	132	13	54	33
Weddell seal	87	210	173	5	66	29
Northern elephant seal	97	216	207	4	71	25

(i) Calculate the total mass of haemoglobin in a Northern elephant seal.

(3)

Answer .....

* (ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 9 marks)

Q7.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Acute respiratory distress syndrome (ARDS) is a condition that can occur in babies.

In ARDS, cells in the alveoli do not produce enough of a substance called surfactant.

The alveoli cannot expand sufficiently when the baby inhales.

The diagram shows the alveoli of a baby with ARDS and the alveoli of an unaffected baby.



Alveoli of a baby with ARDS



Alveoli of an unaffected baby

The surfactant in the alveoli reduces the surface tension of water.

(i) Which bond is responsible for the cohesive forces between water molecules

that contribute to the surface tension of water?

(1)

☒ **A** covalent

☒ **B** ionic

☒ **C** hydrogen

☒ **D** hydrophobic

(ii) Surfactant contains phospholipid molecules.

How many of the following components are found in phospholipids?

(1)

1 amino acids

2 fatty acids

3 glycerol

4 phosphate

☒ **A** one

☒ **B** two

☒ **C** three

☒ **D** four

(Total for question = 2 marks)

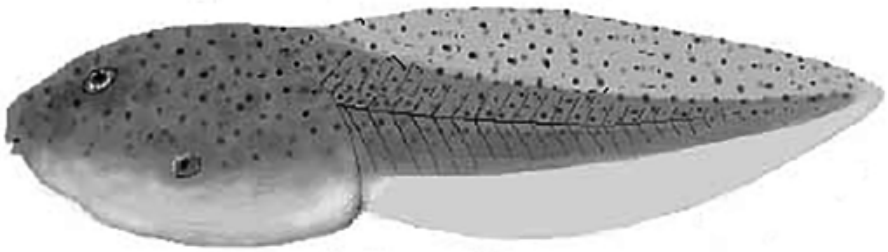
Q8.

The adult American bullfrog, *Rana catesbeiana*, can live in water or on land.

Adult frogs lay eggs in water where they are fertilised.

The fertilised eggs develop into tadpoles that live only in water.

The photograph shows a tadpole.



Adult frogs use lungs for gas exchange but tadpoles use gills.

Explain how gills are adapted for gas exchange.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

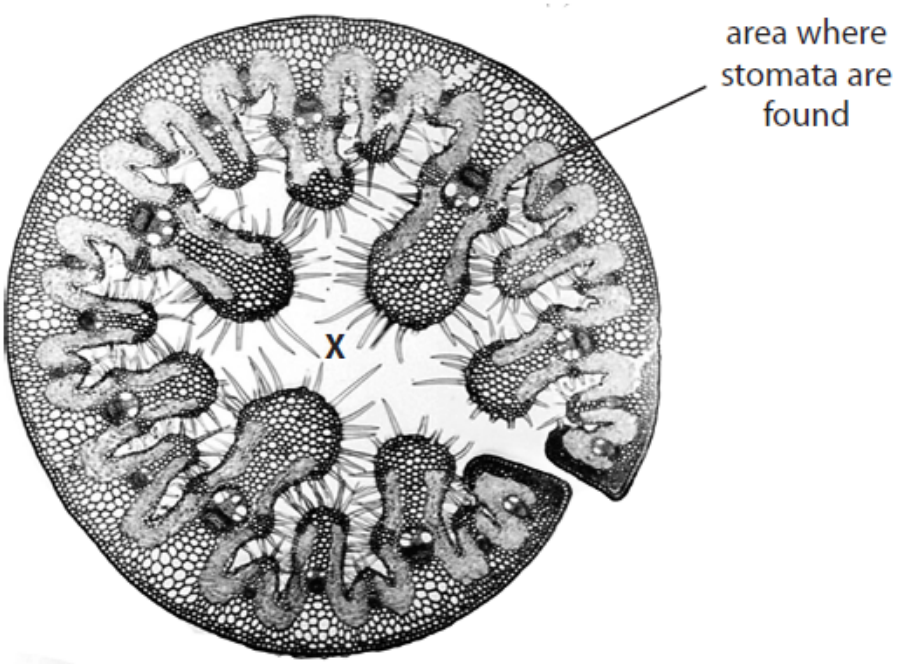
.....

(Total for question = 3 marks)

Q9.

Marram grass leaves are adapted to enable the plants to survive in dry soil.

The photograph shows a section of a marram grass leaf, as seen using a light microscope.



Explain how the structure of this leaf ensures that the water potential at X remains high.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

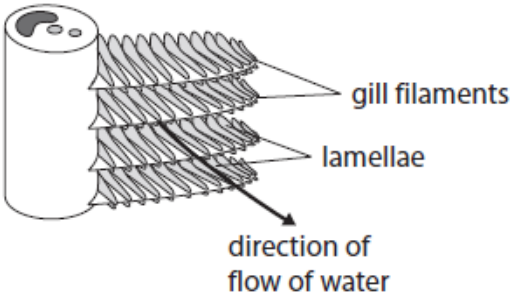
(Total for question = 3 marks)

Q10.

Plants and animals are adapted for gas exchange.

The gas exchange surfaces of fish are the gills.

The diagram shows part of the structure of a gill.



Fish can be divided into two groups: species of fish that are active and species of fish that are inactive.

The table shows some information about some species of fish and their gills.

Species of fish	Mass of fish / g	Total number of gill filaments	Number of lamellae on each side of filament per mm	Surface area of gills / cm^2 per g of fish	Diffusion distance between water and blood / µm
Active species					
Trachurus	26	1665	39	7.8	2.2
Lucioperca	70	1811	15	18.0	no data
Salmo	394	1606	19	2.0	6.4
Katsuwonus	3258	6066	32	13.5	0.6
Thunnus	26600	6480	24	8.9	no data
Inactive species					
Callionymus	39	478	16	2.1	no data
Ictalurus	239	no data	10	1.2	no data
Opsanus	251	660	11	1.9	5.0
Tinca	268	1764	22	1.8	2.5

(i) Lamellae are present on both sides of the gill filaments.

The mean length of a gill filament is 25 mm.

Calculate the total number of lamellae on the gill filaments of *Thunnus*.

Express your answer in standard form.

(1)

Answer .....

* (ii) Analyse the data to explain the relationships between the activity of these fish and the structure of their gills.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q11.

The photographs show leaves from six species of plant.



Daffodil



Frogbit floating on water



Sunflower



Maize



Oak tree



Pea

In an investigation into transpiration, a survey was carried out to measure the distribution of stomata on leaves.

The table shows the results of this investigation.

Plant species	Density of stomata in leaf surface / number per mm²	
	Upper epidermis	Lower epidermis
Beech tree	0	340
Daffodil	65	68
Frogbit (floating leaf)	89	0
Maize	52	58
Oak tree	0	450
Pea	100	220
Sunflower	85	156
Sycamore tree	0	860

Analyse the data and the photographs to explain the distribution of the stomata.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q12.

The photographs show leaves from six species of plant.



Daffodil



Frogbit floating on water



Sunflower



Maize



Oak tree

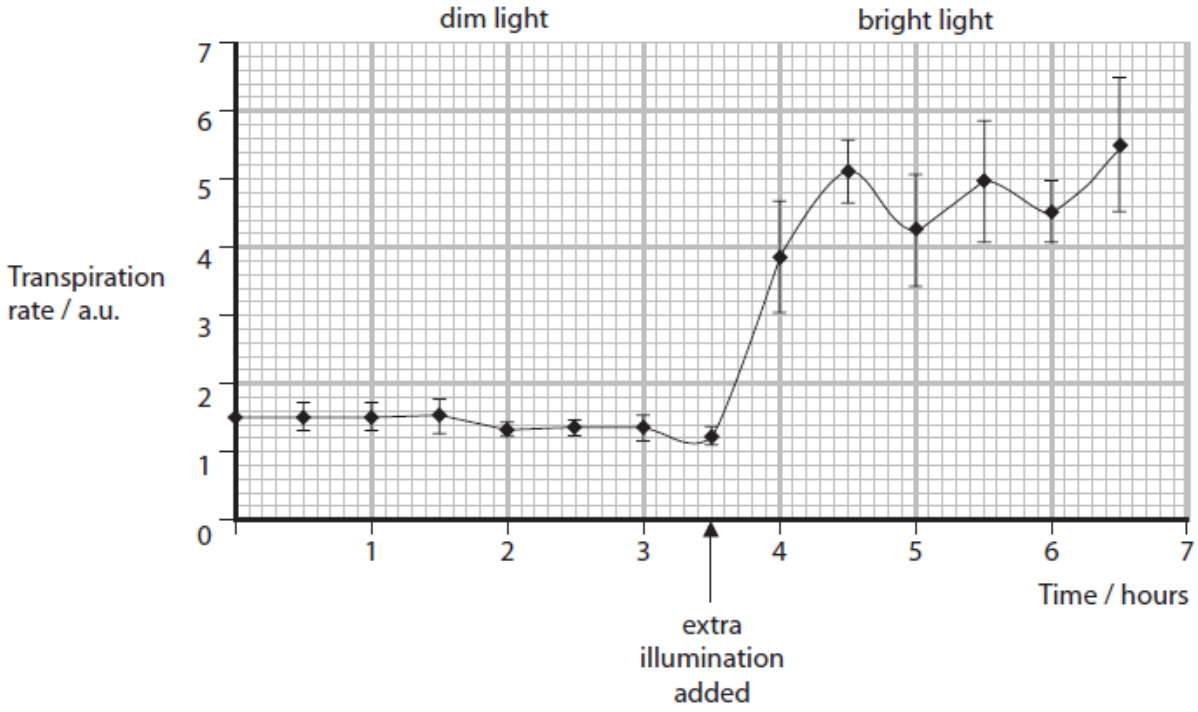


Pea

As part of this investigation, the effect of light on the transpiration rate of seven-day-old maize seedlings was measured.

The transpiration rate of maize seedlings placed in dim light was measured every 30 minutes for 3.5 hours. Extra illumination was then added and the transpiration rate again measured every 30 minutes for another 3.5 hours.

The graph shows the results of this investigation.



(i) Calculate the approximate percentage increase in the transpiration rate due to the extra illumination.

(2)

Answer .....

(ii) Explain two factors that should have been controlled in this investigation.

(2)

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q13.

Plants and animals are adapted for gas exchange.

(i) Which row of the table describes gas exchange in the root of a plant?

(1)

		Net movement of carbon dioxide	Net movement of oxygen
☒	**A**	in only	out only
☒	**B**	out only	in only
☒	**C**	in and out	in and out
☒	**D**	neither in nor out	neither in nor out

(ii) Which is the gas exchange surface in the stem of a woody plant?

(1)

☒ **A** lenticel

☒ **B** pit

☒ **C** plasmodesmata

☒ **D** stomata

(Total for question = 2 marks)

Q14.

Describe how oxygen from the air is able to reach insect muscle cells.

(3)

.....

.....

.....

.....

.....

.....

.....

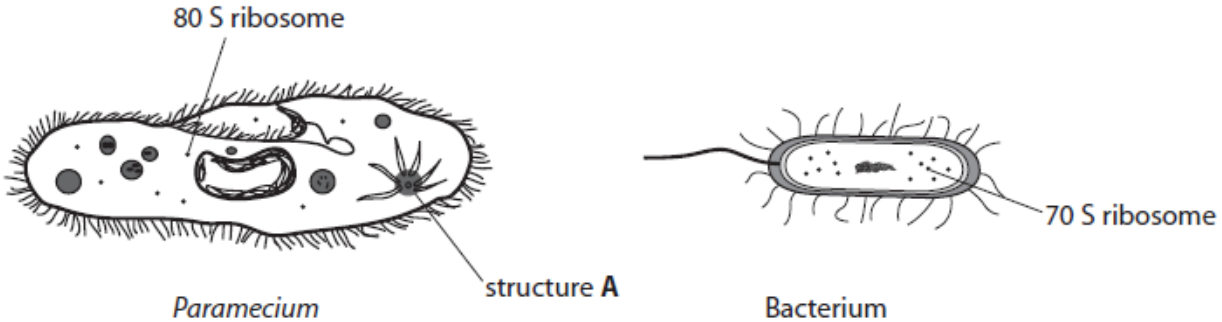
.....

.....

(Total for question = 3 marks)

Q15.

The drawings show two single-celled organisms that live in ponds, *Paramecium* and a bacterium.

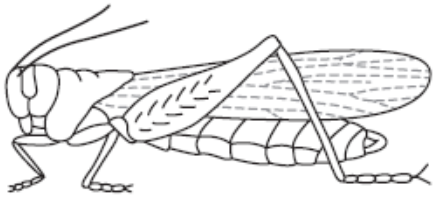


Paramecium
Magnification ×200

Bacterium
Magnification ×5000

(i) Many living organisms need a gas exchange system.

The drawing shows a locust.



Magnification ×1

Explain why a locust has a gas exchange system whereas a *Paramecium* does not.

(2)

.....

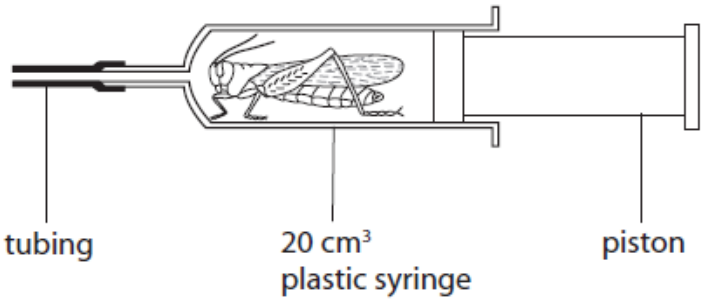
.....

.....

.....

.....

(ii) A student placed a locust inside a transparent syringe and observed the movement of the abdomen.

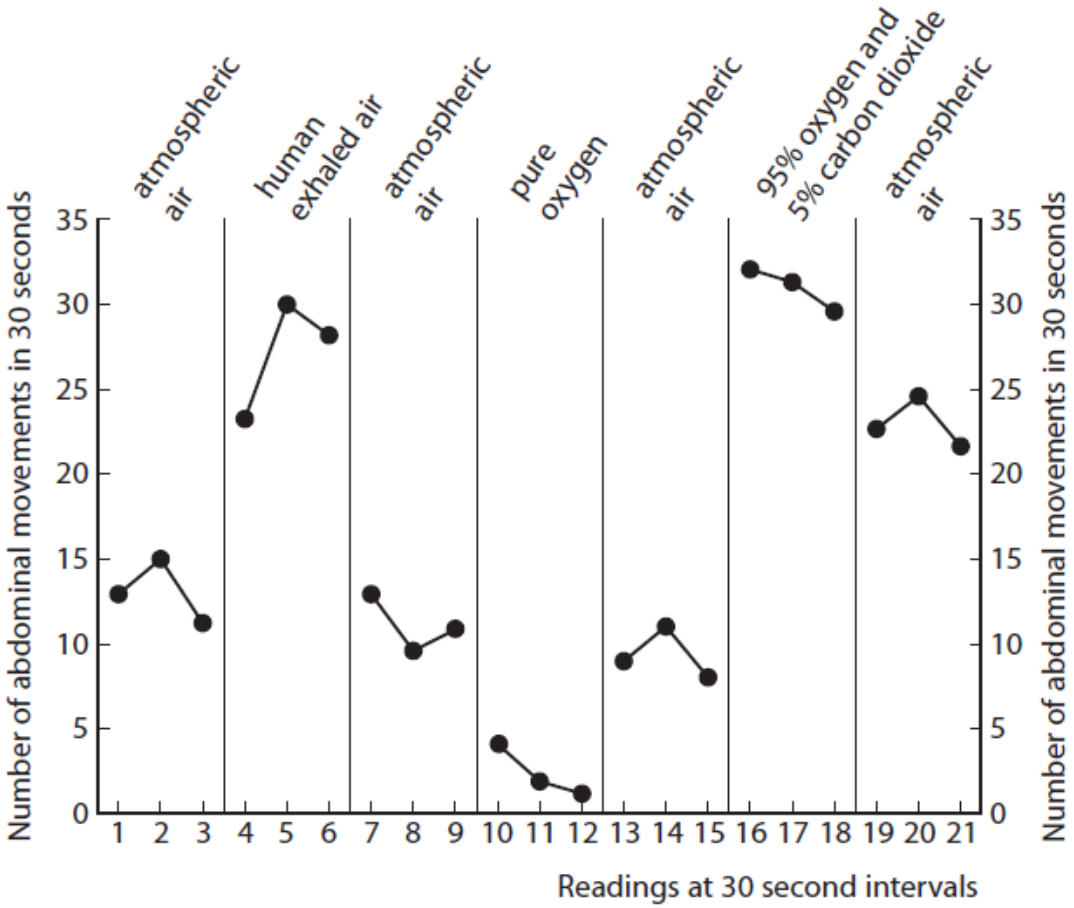


The student recorded the number of times the abdomen pumped in 30 seconds. This was carried out three times.

The syringe was then flushed with atmospheric air and the procedur repeated first with air exhaled by a human, then pure oxygen and then a mixture of 5% carbon dioxide and 95% oxygen.

The syringe was flushed with atmospheric air in between each treatment.

The results are shown in the graph on page 14.



* Analyse the data to assess the effect of oxygen and carbon dioxide on locust abdominal pumping.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

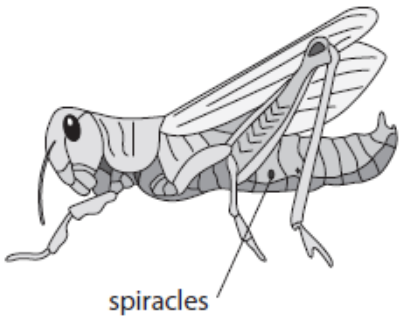
.....

Q16.

Insects such as locusts do not breathe through the mouth.

The gas exchange system of a locust includes air sacs, tracheae and tracheoles.

The diagram shows a locust before dissection.



Explain the role of air sacs in the gas exchange system of locusts.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 2 marks)

Q17.

Plants and animals are adapted for gas exchange.

Spiracles are small openings in the exoskeletons of insects that allow air to enter the respiratory system.

Water can evaporate out of the spiracles when they are open. The insect can close the spiracles to reduce water loss.

In an investigation, the water loss from insects in air with different humidities was measured.

The insects were kept in air with 80% humidity and then moved into air with a lower humidity. Water loss was then measured.

The investigation was repeated in air high in carbon dioxide to keep the spiracles open.

The table shows the results of this investigation.

Percentage humidity (%)	Water loss from insects / mg hr^{-1}	
	Insects in air	Insects in air high in carbon dioxide
0	0.10	0.90
20	0.13	0.68
40	0.15	0.50
60	0.13	0.35
80	0.07	0.07

(i) State how the water loss could have been measured in this investigation.

(1)

.....

.....

.....

(ii) Calculate the percentage increase in water loss from the insects kept in air at 0% humidity compared with those kept at 80% humidity.

Give your answer to two decimal places.

(1)

Answer ..... %

(iii) Explain why the insects were kept in air with 80% humidity at the start of this investigation.

(2)

.....

.....

.....

.....

.....

.....

(iv) Explain the results of this investigation.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q18.

A student planned to keep two species of fish in an aquarium.

One species of fish should be kept at a minimum temperature of 25 °C. The other species requires a minimum concentration of oxygen of 7.5 mg dm^{-3} water.

The student investigated the effect of water temperature on the solubility of oxygen in water.

The table shows the results of this investigation.

Water temperature / °C	Solubility of oxygen in water / mg dm^{-3}
0	14.2
10	11.5
20	12.0
30	7.7
40	7.8
50	5.9
60	5.3

The student used a statistical test on these data.

(i) Which is the correct statistical test to use on these data?

(1)

☒ **A** Chi squared test

☒ **B** correlation coefficient

☒ **C** standard deviation

☒ **D** Student's t test

(ii) The student analysed the data using the formula:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

The student calculated $\sum d^2$ to be 108.

Use the formula to calculate r_s.

(3)

Answer .....

(iii) Explain how the student should use the r_s value calculated in part (ii) to find the strength of the relationship between these two variables.

(2)

.....

.....

.....

.....

.....

(Total for question = 6 marks)

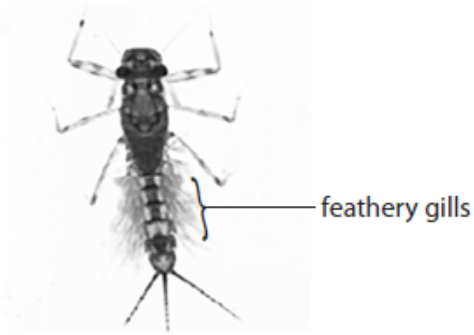
Q19.

The photograph shows an adult mayfly.



Mayfly eggs hatch into immature insects called nymphs. The nymphs live in the water and develop to form adult mayflies.

The photograph shows a mayfly nymph.



Compare and contrast the structure of the gas exchange system of the mayfly nymph with the adult mayfly.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)