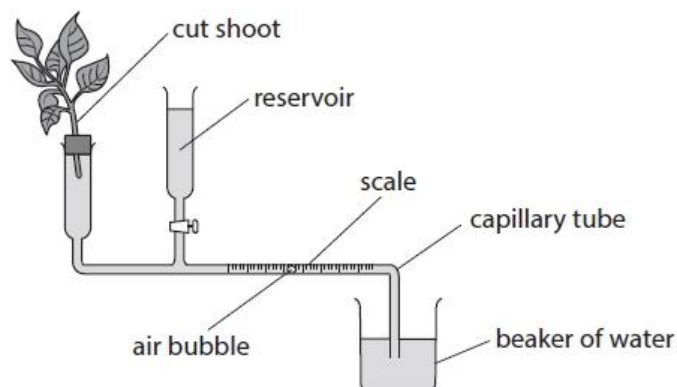


Questions**Q1.**

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 $\text{mm}^3 \text{min}^{-1}$ to two significant figures.

(3)

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

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

(3)

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(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.

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(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.

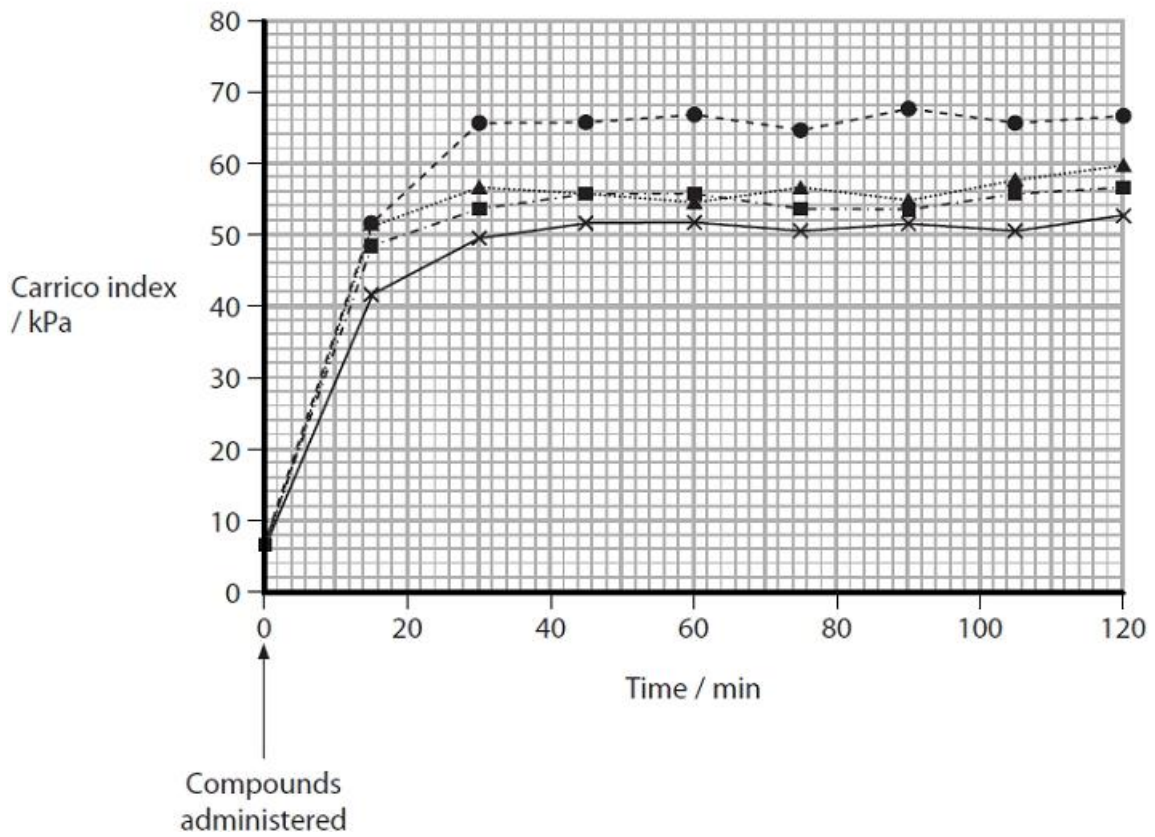
Each group of rabbits was given a different treatment.

- 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.

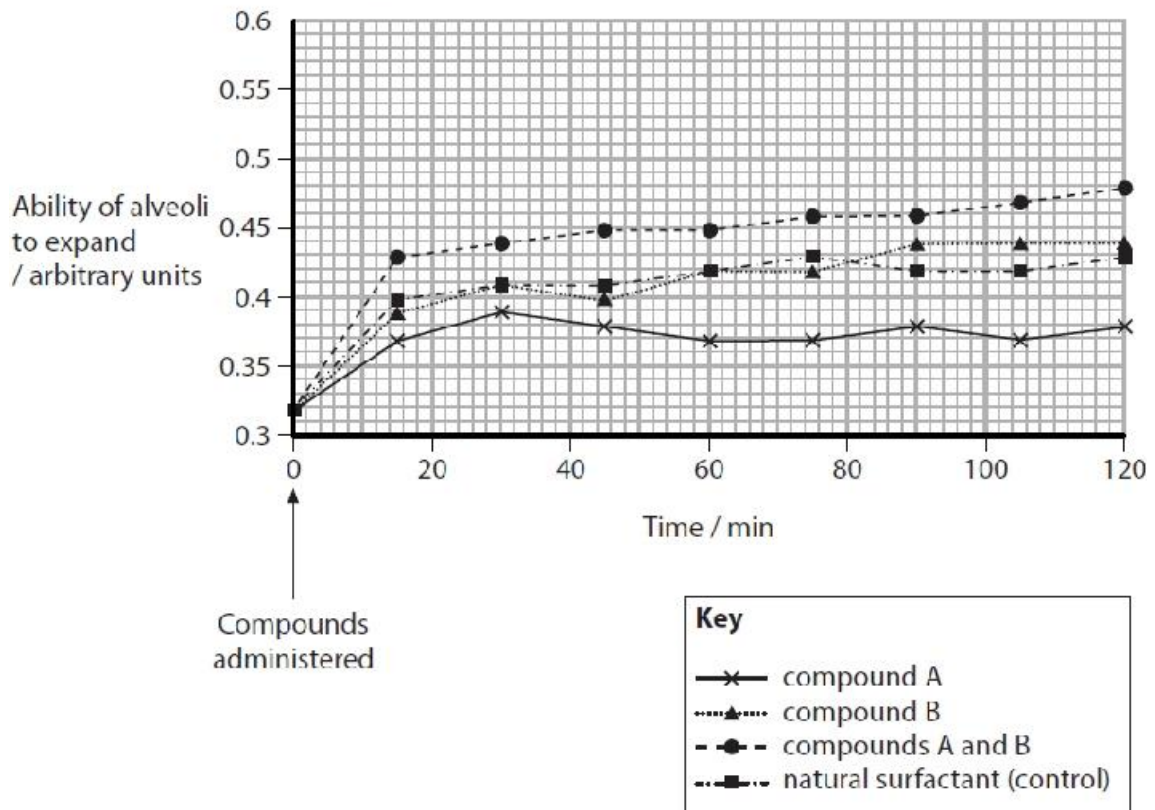
The mean Carrico index of each group of rabbits and the ability of the alveoli to expand were determined every 15 minutes.

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)

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(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)

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(Total for question = 5 marks)

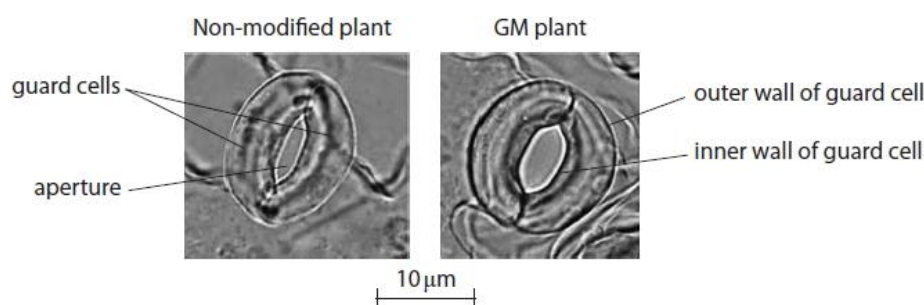
Q4.

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.

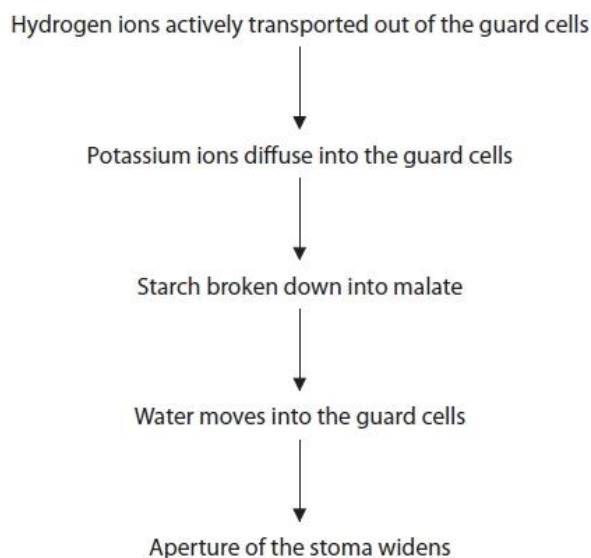
This difference in the width of the aperture is only evident in daylight.

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?

- 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

(1)

(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.

Gills are the site of gas exchange in fish.

The table shows some information for five species of fish.

Fish species	Activity level	Surface area of gill lamellae / mm ²	Mass of fish / g	Comparison of surface area to mass / cm ² g ⁻¹
toadfish	low	46 055	305	1.51
butterfish	medium	120 321	261	4.61
sheepshead	medium	254 048	544	4.67
mullet	high	252 500	250	
mackerel	high	235 040	226	10.40

(i) The comparison of surface area to mass of mullet is

(1)

- A 1010 cm² g⁻¹
- B 10.10 cm² g⁻¹
- C 1.01 cm² g⁻¹
- D 0.99 cm² g⁻¹

(ii) Analyse the data to explain the difference in the activity levels of these fish species.

(3)

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(Total for question = 4 marks)

Q6.

The lungs do not consist of two large spheres. They contain 6000 million small, spherical alveoli.

(i) Explain how having many alveoli increases the efficiency of the diffusion in the lungs.

(2)

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(ii) Explain how other features of alveoli enable efficient diffusion in the lungs.

(3)

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(Total for question = 5 marks)

Q7.

The CFTR protein is also found in the membrane of epithelial cells in the lungs.

Cystic fibrosis is a recessive genetic condition caused by mutations of the allele for the CFTR protein.

This can result in the production of thick, highly viscous mucus in the bronchioles and bronchi.

Explain why the blood of people with cystic fibrosis has a low oxygen concentration.

(2)

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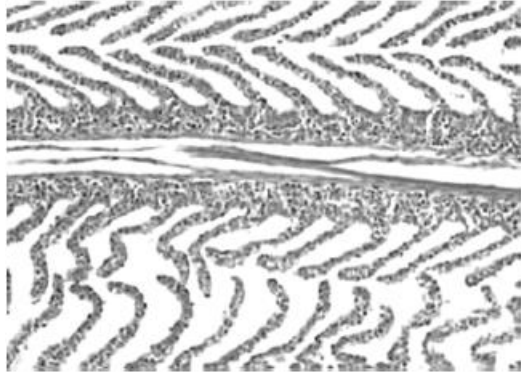
(Total for question = 2 marks)

Q8.

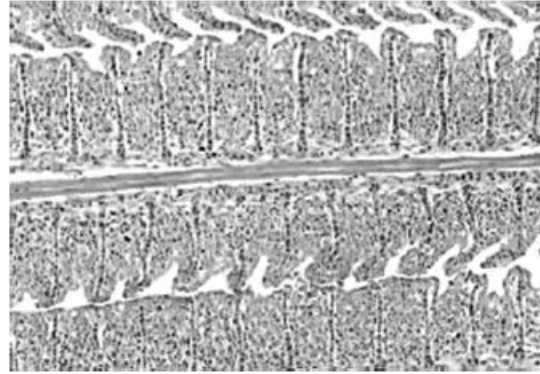
Gills are the site of gas exchange in fish.

Water polluted with heavy metal ions can cause the death of fish.

The photographs show cross-sections of the lamellae from a fish caught in unpolluted water and from a fish caught in water polluted with heavy metal ions.



Gill lamellae from a fish in unpolluted water



Gill lamellae from a fish in water polluted with heavy metal ions

Use the photographs to explain why fish die in water polluted with heavy metal ions.

(2)

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(Total for question = 2 marks)

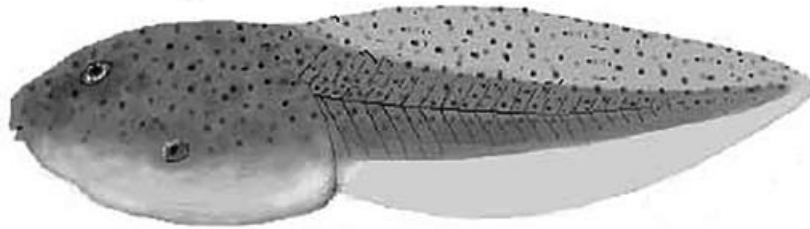
Q9.

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)

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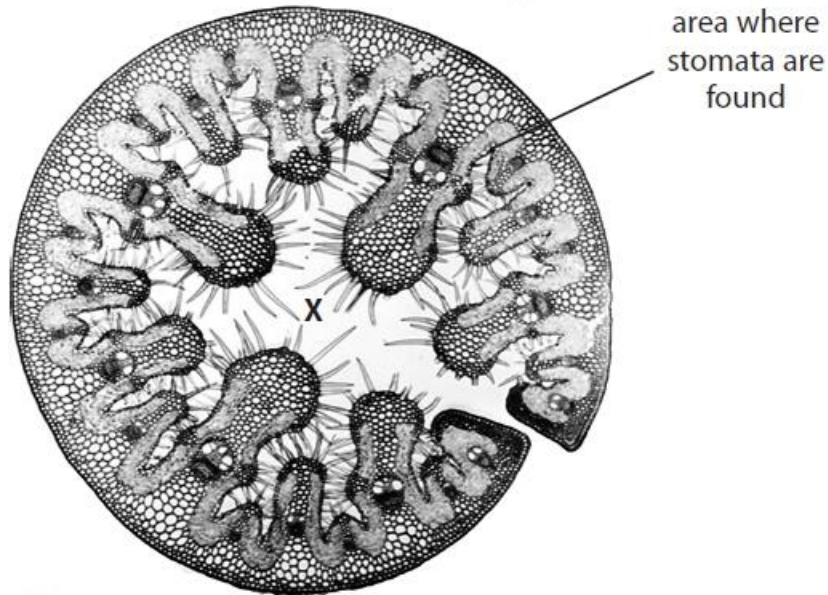
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(Total for question = 3 marks)

Q10.

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)

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(Total for question = 3 marks)

Q11.

Explain the features of gas exchange surfaces that are common to both insects and mammals.

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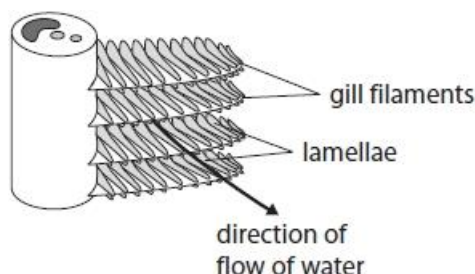
(Total for question = 4 marks)

Q12.

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					
<i>Trachurus</i>	26	1665	39	7.8	2.2
<i>Lucioperca</i>	70	1811	15	18.0	no data
<i>Salmo</i>	394	1606	19	2.0	6.4
<i>Katsuwonus</i>	3258	6066	32	13.5	0.6
<i>Thunnus</i>	26600	6480	24	8.9	no data
Inactive species					
<i>Callionymus</i>	39	478	16	2.1	no data
<i>Ictalurus</i>	239	no data	10	1.2	no data
<i>Opsanus</i>	251	660	11	1.9	5.0
<i>Tinca</i>	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)

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(Total for question = 7 marks)

Q13.

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 mm ²	
	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.

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(Total for question = 5 marks)

Q14.

The photographs show leaves from six species of plant.



Daffodil



Frogbit floating on water



Sunflower



Maize



Oak tree

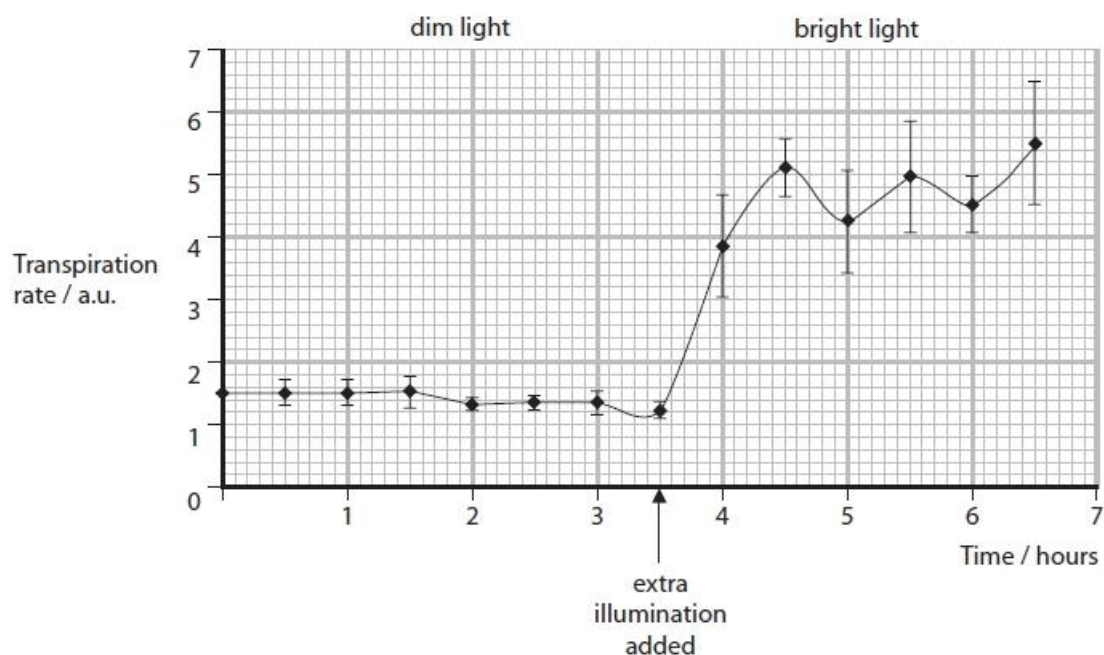


Pea

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)

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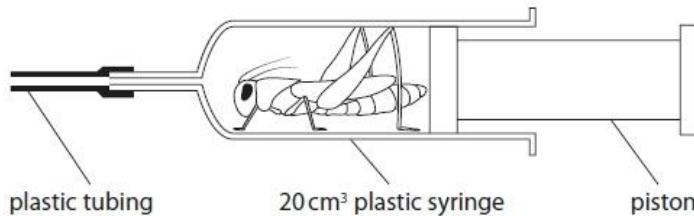
(Total for question = 4 marks)

Q15.

The effect of gas composition on the breathing rate of locusts was investigated.

The method used was:

Step 1 A locust was placed in a 20 cm³ clear plastic syringe, as shown in the diagram. The piston was inserted so it gently held the locust in place so that the locust had no room to move.



- Step 2** The number of pumping movements of the abdomen which occurred in 30 seconds was counted. This was repeated three more times.
- Step 3** Gases of different compositions were added to the syringe through the plastic tubing.
- Step 4** For each different composition of gases, the number of pumping movements of the abdomen which occurred in 30 seconds was counted.
- Step 5** Between each composition of gases used, the piston was moved in and out ten times to replace the exhaled air with laboratory air.
- Step 6** The locust was then left for 5 minutes before the next composition of gases was added.

Analyse the data to comment on the effect gas composition has on the breathing rate of this locust.

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(Total for question = 4 marks)

Q16.

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
<input type="checkbox"/> A	in only	out only
<input type="checkbox"/> B	out only	in only
<input type="checkbox"/> C	in and out	in and out
<input type="checkbox"/> 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)

Q17.

The photograph shows an insect.



Explain how the gas exchange system of an insect is adapted for the efficient uptake of oxygen.

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(Total for question = 4 marks)

Q18.

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

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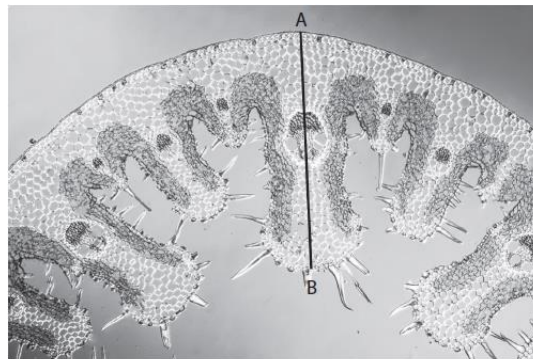
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(Total for question = 3 marks)

Q19.

The photograph shows a cross-section of a leaf from marram grass, *Ammophila arenaria*, as seen using a light microscope.



Source: © Dr. Norbert Lange/Shutterstock

Marram grass grows in sand dunes where little freshwater is available.

- (i) The line AB shown on the actual leaf sample is 4 mm.
Calculate the magnification of the photograph.

(2)

Answer

- (ii) Explain how **two** of these adaptations enable this plant to survive in dry sand.

(2)

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- (iii) Marram grass also contains extra xylem tissue that strengthens the leaves.
Explain why these plants need extra xylem in their leaves.

(2)

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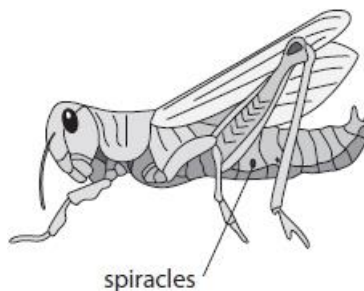
(Total for question = 6 marks)

Q20.

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)

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(Total for question = 2 marks)

Q21.

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)

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(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)

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(iv) Explain the results of this investigation.

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(Total for question = 7 marks)

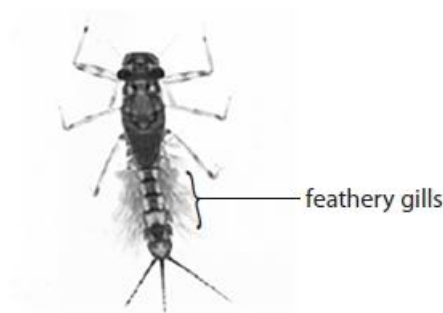
Q22.

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.

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(Total for question = 3 marks)

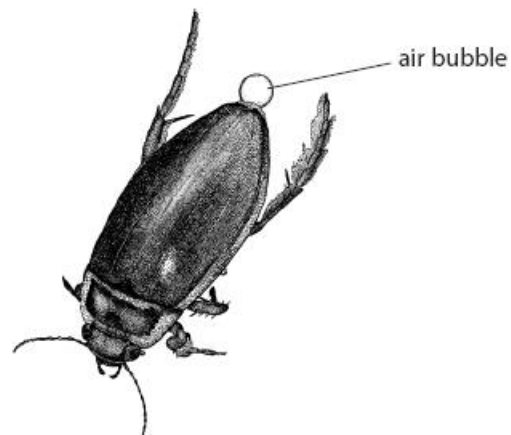
Q23.

The insect *Dytiscus marginalis* is a beetle that can dive underwater to feed.

Before diving underwater, the beetle traps an air bubble underneath its wings.

The air bubble is connected to its spiracles.

The diagram shows a beetle with an air bubble attached to its body.



State how the oxygen in the air bubble reaches the cells in the beetle.

(1)

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(Total for question = 1 mark)

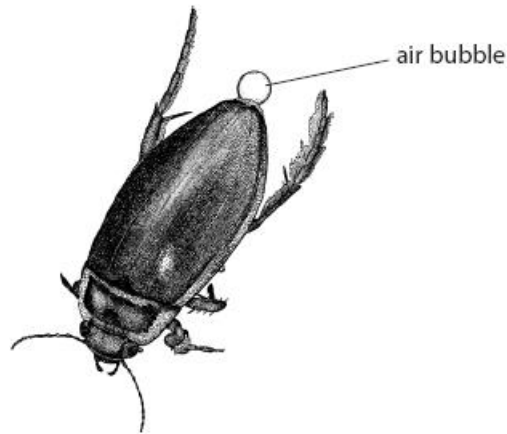
Q24.

The insect *Dytiscus marginalis* is a beetle that can dive underwater to feed.

Before diving underwater, the beetle traps an air bubble underneath its wings.

The air bubble is connected to its spiracles.

The diagram shows a beetle with an air bubble attached to its body.



When the beetle is underwater, gases can enter or leave the air bubble.

These gas movements affect the size of the bubble.

When the beetle first dives, the concentration of oxygen is higher in the bubble than in the water.

Explain why these facts will affect the time the beetle can stay underwater.

(3)

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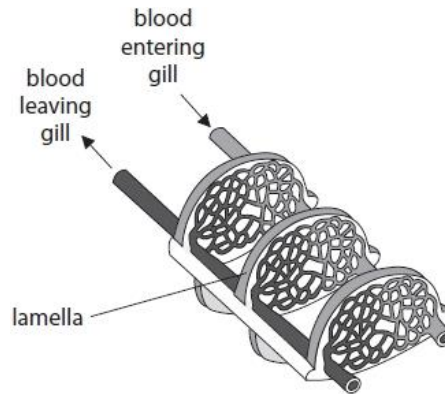
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(Total for question = 3 marks)

Q25.

Gills are the site of gas exchange in fish.

The diagram shows some of the gill lamellae from a bony fish.



Draw **one** arrow on the diagram to show the direction of water flow across the lamellae.

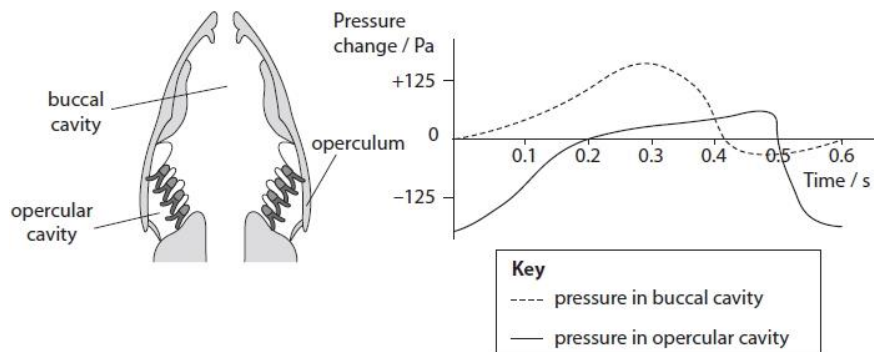
(1)

(Total for question = 1 mark)

Q26.

The diagram shows a section through the head of a bony fish.

The graph shows the pressure changes in the buccal cavity and opercular cavity during ventilation.



The operculum will be closed between

- A 0.4 s and 0.5 s
- B 0.0 s and 0.4 s
- C 0.4 s and 0.6 s
- D 0.2 s and 0.4 s

(1)

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>A calculation that shows the following stages</p> <ul style="list-style-type: none"> • use manipulation of units to mm (1) • calculation of volume of cylinder (1) • rate per minute calculated to 2sf (1) 	<p>Example of calculation:</p> <p>eg mean is 64 (mm)</p> <p>4.522 / 4.524 (this gets mp1 and 2 if 64 not seen) 45.2 is correct value if 6.4 is used</p> <p>0.90</p> <p>Correct answer with no working gains 3 marks</p> <p>0.9 gets 2 marks (not 2sf) 0.09 gets 2 marks (if 6.4 is used for distance) 18 gets 2 marks (if diameter is used) 4.5 gets 2 marks (2sf if they do not divide by 5)</p>	Exp (3)
Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that includes three of the following</p> <ul style="list-style-type: none"> • {water uptake / transpiration} is fastest in moving air in the light (1) • {water uptake / transpiration} {is very slow / stops / decreases} in the dark as stomata close (1) • {water uptake / transpiration} is faster in moving air (than still air) as the diffusion gradient is {maintained / steeper} (1) • comment on decline in rate (of transpiration / water uptake) as trials continue in darkness with explanation (1) • effect of light is greater than effect of moving air (1) 	<p>Accept {water uptake / transpiration} is slowest in still air in the dark</p> <p>Not converse</p> <p>Accept concentration gradient / water potential gradient / diffusion shells around stomata or leaf Accept converse</p> <p>Accept stomata do not close completely until trial 3</p>	Exp (3)

Question Number	Answer	Additional Guidance	Mark
(iv)	<p>A description that includes four of the following:</p> <ul style="list-style-type: none"> • cover one surface of leaves with vaseline / petroleum jelly / clear tape (to prevent transpiration) • measure {rate / distance moved in 5 mins / volume of water taken up in 5 mins} (1) • ensure that covering is fully removed or use another shoot with same surface area (1) • repeat for other surface of leaves (and compare results) (1) • method of control of one named variable / monitoring named variable which cannot be controlled (1) • repeats for each set up and calculate standard deviation (1) 	<p>Accept clear nail varnish / clingfilm</p> <p>Accept other times Accept time how long it takes to move a set distance</p> <p>Accept same number of leaves / similar surface area Accept calculate rate of water loss per unit area</p> <p>Piece together</p> <p>Accept eg. temperature – AC room / room temperature humidity - clear bag over plant light intensity – distance from lamp air movement - distance from fan</p> <p>Accept repeat and carry out appropriate stats test eg t-test, 95% confidence limits, Mann Whitney U test</p>	<p>Exp (4)</p>

Q2.

Question Number	Indicative content
★	<p>Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Indicative content</p> <p>Descriptions (D)</p> <ul style="list-style-type: none"> • A, B increase Carrico index / alveolar expansion • A and B together gives the highest level of improvement in Carrico index / more than natural surfactant • Both compounds A and B together are best to treat ARDS / increase the Carrico index • A alone is least effective • B increases Carrico index more than A • in all cases, the improvement is rapid and persists from 30 to 120 minutes <p>Analysis (A)</p> <ul style="list-style-type: none"> • valid comparison with natural surfactant / control • B has similar increase in Carrico index as natural surfactant / control • A has lower increase compared to natural surfactant / control • positive correlation between alveoli expansion and Carrico index • improving alveoli expansion results in improvement in blood oxygenation which improves Carrico index • the artificial surfactants allow alveoli to expand, increasing surface area and oxygen diffusion into blood • unaffected baby has index of 67 which is what A and B reach <p>Potential use (P)</p> <ul style="list-style-type: none"> • rabbits may not respond in the same way as humans to the compounds • may not be safe in humans • small sample size • no comparison has been made with no surfactant

Level	Marks	
0	0	No awardable content
1	1-2	<p>An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information with some attempt made to link knowledge and understanding</p> <p>Only D</p>
2	3-4	<p>An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning with some structure.</p> <p>D + A or D+ P</p>
3	5-6	<p>An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p> <p>D+A+P</p>

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> data correctly substituted into equation <p>14 / 14.1 / 14.07</p>	<p><u>Example of calculation</u></p> <p>(67 x 0.21 =) 14</p>	1

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> less oxygen in blood / capillaries / lower partial pressure of oxygen in blood (1) because alveoli have less surface area (1) because (lack of surfactant) prevents expansion (1) less air / oxygen inhaled (1) 	ACCEPT more likely to collapse	4

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	D ATP is broken down into ADP and phosphate ions by a hydrolysis reaction	<p>A is incorrect because ATP is broken down</p> <p>B is incorrect because ATP is broken down C is incorrect because condensation reactions form bonds</p>	

Question Number	Answer	Additional Guidance	Mark
(ii)	A malate lowers the water potential of the cytoplasm	<p>B is incorrect because increase in solute concentration raises water potential so water would leave the cells</p> <p>C is incorrect because starch has no osmotic effect</p> <p>D is incorrect because starch has no osmotic effect</p>	

Question Number	Answer	Additional Guidance	Mark
(iii)	D The guard cells become larger and the inner wall of the guard cell is less flexible than the outer wall	<p>A is incorrect because entry of water would make the cell more larger</p> <p>B is incorrect because entry of water would make the cell more larger</p> <p>C is incorrect because the stoma would not form if the inner wall was flexible</p>	

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	B ($10.10 \text{ cm}^2 \text{ g}^{-1}$)		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: <ul style="list-style-type: none"> • more active fish have higher surface area : mass ratio (1) • therefore they can absorb more oxygen (1) • for respiration for more muscle contraction (1) 	ALLOW converse IGNORE gas exchange	(3)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: <ul style="list-style-type: none"> • increases surface area to volume ratio (1) • more oxygen into {blood / capillaries} / more carbon dioxide out of {blood / capillaries} (1) 		(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: <ul style="list-style-type: none"> • {alveoli / capillaries} are thin / one cell thick / close to each other} so short diffusion distance (1) • {blood supply / blood flow / capillaries} maintains {diffusion / concentration} gradient (1) • {moist / surfactant} to allow gases to dissolve / surfactant prevents collapse of alveoli (1) 		(3)

Q7.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> airways blocked / narrowed (1) therefore less oxygen to alveoli / less air enters alveoli / less gas exchange / lower concentration gradient / less diffusion (into blood) (1) 	ACCEPT less space / reduced pathway	(2)

Q8.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> gill lamellae {are thicker / swollen / touching / less surface area / less contact with water} / have decreased water flow (1) therefore less gas exchange / oxygen uptake (1) 		(2)

Q9.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • large surface area (to volume ratio) for diffusion (1) • thin for shorter diffusion distance (1) • {blood flow / countercurrent} to maintain {diffusion gradient / concentration gradient} (1) 	DO NOT ACCEPT thin membranes	(3)

Q10.

Question Number	Answer	Mark
	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> • less {evaporation / transpiration / diffusion} (1) • because {leaf is curled / small gap / hairs / sunken stomata / stomata in pits / waxy cuticle} (1) • trap water vapour / reduce {diffusion / concentration / water potential} gradient (1) 	(3)

Q11.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to four of the following points:</p> <ul style="list-style-type: none"> • large surface area (1) • because of many tracheoles and alveoli (1) • short distance for diffusion (1) • because alveoli and tracheoles have thin walls (1) • moist to allow gases to dissolve (1) 	<p>IGNORE thin membranes</p> <p>ACCEPT because tracheoles penetrate tissue, alveoli close to blood capillaries</p>	(4)

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	• 7.776×10^6 / 7.78×10^6 / 7.8×10^6 / 8×10^6		(1) GRAD

Question Number	Indicative content		Mark
* (ii)	<p><u>Indicative content</u></p> <p>Gill filaments:</p> <ul style="list-style-type: none"> • active fish (generally) have a greater number of gill filaments than inactive fish • the exception is the heaviest inactive fish, <i>Tinca</i> • maybe a weak correlation between number of filaments and mass of active fish <p>Lamellae:</p> <ul style="list-style-type: none"> • active fish (generally) have more lamellae on each filament • but this does not correlate with the mass of the fish • <i>Tinca</i> is the inactive fish with the highest total number of gill filaments • 1.9×10^6 • which is way lower than <i>Thunnus</i> • and only slightly above the active fish with the least number Surface area: • active fish (generally) have a greater surface are of gills than inactive fish of similar mass • but no correlation with mass Diffusion distance: • very little data on diffusion distance • active fish seem to hoave a smaller diffusion distance • but no obvious correlation with activity or mass <p>Explanations:</p> <ul style="list-style-type: none"> • higher {number of filaments / lamellae / surface area} increases gas exchange • a smaller diffusion increases gas exchange 	<p>Level 1:</p> <p>1 mark = one gill aspect commented on 2 marks = two gill aspects commented on</p> <p>Level 2:</p> <p>3 marks = two gill aspects commented on with an explanation 4 marks = three gill aspects commented on with an explanation</p> <p>Level 3:</p> <p>5 marks = four gill aspects commented on, with an explanation 6 marks = four gill aspects commented on, with an explanation linking to muscle contraction</p>	6 EXP
	<ul style="list-style-type: none"> • so more oxygen available for aerobic respiration • therefore more ATP can be generated • for the contraction of muscles (of the active fish) • more energy needed for movement of heavier fish 		

Q13.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to five of the following:</p> <ul style="list-style-type: none"> • carbon dioxide is absorbed through the stomata and water is lost (1) • recognition of two patterns of stomatal distribution(1) <p>Trees (beech, oak, sycamore) plus pea & sunflower</p> <ul style="list-style-type: none"> • plants {with leaves lying flat / have most stomata on the lower surface} to reduce water loss from direct sunlight (1) <p>Frogbit</p> <ul style="list-style-type: none"> • {upper surface in contact with air, lower surface with water / (therefore the) frogbit has all the stomata on the upper surface because it is not short of water} (1) <p>Daffodil & maize</p> <ul style="list-style-type: none"> • leaves are {upright / exposed to equal amounts of light} so have stomata on both surfaces (1) 	<p>Allow {more on upper / more on lower / equal distribution}</p> <p>Allow stomata on lower surface allow {carbon dioxide to enter / gas exchange}</p> <p>Allow it needs to absorb carbon dioxide from the air</p>	(5)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> rate at low light intensity and high light intensity estimated (1) percentage increase calculated (1) 	<p>Acceptable range of rates 1.2 to 1.5 4.5 to 5.5</p> <p>Acceptable range = 200 - 358%</p> <p>Correct answer with no working gains full marks</p>	(2)
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> temperature because it affects the rate of transpiration (1) humidity because it affects the rate of transpiration (1) 	<p>accept other relevant factors eg. windspeed availability of water</p>	(2)

Q15.

Question Number	Answer	Additional guidance	Mark
	<p>An answer that makes reference to the following</p> <ul style="list-style-type: none"> as oxygen increases breathing rate fluctuates / no clear relationship (1) lowest rate at 100% oxygen (1) as carbon dioxide increases so does breathing rate / highest carbon dioxide breathing rate is highest (1) carbon dioxide has a greater effect on breathing rate than oxygen (1) 	<p>allow converse</p>	(4)

Q16.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>The only correct answer is B</p> <p>A is incorrect because respiration takes place in the root</p> <p>C is incorrect because photosynthesis does not take place in the root</p> <p>D is incorrect because respiration takes place in the root</p>		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>The only correct answer is A</p> <p>B is incorrect because pits are in the xylem</p> <p>C is incorrect because plasmodesmata are between cells</p> <p>D is incorrect because stomata are in the leaves</p>		(1) COMP

Q17.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that that makes reference to four of the following:</p> <ul style="list-style-type: none"> • (air/oxygen) into spiracles to tracheae to tracheoles (1) • by diffusion (1) • <u>tracheoles</u> provide large surface area / <u>tracheoles</u> are thin for short diffusion pathway / <u>tracheoles</u> contain fluid to allow oxygen to dissolve / <u>tracheoles</u> supply oxygen to cells / tissues (1) • air sacs provide store of air / oxygen (1) • abdominal movements move air / ventilate / maintain concentration gradient high (1) 		(4)

Q18.

Question Number	Answer	Additional Guidance	Mark
	<p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> • enters through spiracles (1) • diffusion {in tracheae / in tracheoles / into cells} (1) • down concentration gradient (1) 		(3)

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> measurements of line AB and correct units (1) calculation of magnification (1) 	= 51 mm allow 50-52 mm ÷ 4mm = allow 12.75 allow range 12.5 -13 Correct answer gains full marks allow 1 mark for dividing by 4	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following points: <ul style="list-style-type: none"> curved leaves so stomata are on inside of leaf {decrease concentration gradient /increase humidity} (1) hairs reduce air movement (1) stomata in pits to {increase humidity / decrease concentration gradient} (1) (thick) waxy cuticle reduces water evaporation/ loss (from outer surface)(1) 	ACCEPT reduces transpiration rate	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following points: <ul style="list-style-type: none"> because it transports minerals (to the cells) (1) because it transports water (to the cells) (1) to support leaves to absorb light (1) 		(2)

Q20.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • {supply / store of / reservoir of} oxygen (1) • so respiration can occur in {large / active} locusts (1) 		(2)

Q21.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> • insect weighed before and after investigation and the difference calculated (1) 		(1) GRAD

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> • 42.86 (%) 	DO NOT ACCEPT 42.860 or any other numbers	(1) CLER

Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> • as a standard for comparison (1) • to prevent {water loss / dehydration} (before the start of the investigation) (1) • as this is the highest humidity {they could tolerate / that could be produced} (1) 	<p>ACCEPT a description e.g. so that the effects of lower humidities can be seen</p> <p>ACCEPT reduce water loss so there will be water in the tracheoles</p> <p>IGNORE water enters spiracles</p> <p>ACCEPT higher humidities might be harmful</p>	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> • water loss increases with decrease in humidity as there is more room for water molecules (1) • less water loss at {low / 20% / 0%} humidity in air because spiracles close (1) • water loss is greater in air with higher levels of carbon dioxide as ventilation rate is faster (1) • and the spiracles stay open (1) 	<p>ACCEPT converse where appropriate</p> <p>ACCEPT fewer water molecules in air / down a (water vapour) concentration gradient (into air)</p> <p>ACCEPT breathing rate / gas exchange</p>	(3) EXP

Q22.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to three of the following:</p> <p>Similarities:</p> <ul style="list-style-type: none"> • large surface area (1) • thin exchange surface / small diffusion distances (1) <p>Differences:</p> <ul style="list-style-type: none"> • nymphs have gills and adults have trachea / spiracles (1) • the nymph has external system and the adult has internal system (1) 	<p>DO NOT PIECE TOGETHER</p> <p>ACCEPT both have tracheoles if not awarded as a difference</p> <p>ACCEPT tracheoles if not awarded as a similarity ACCEPT gills on the outside and {spiracles / trachea / tracheoles} are on the inside</p>	(3)

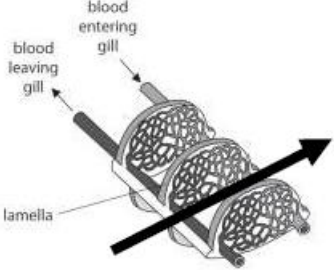
Q23.

Question Number	Answer	Additional guidance	Mark
	<ul style="list-style-type: none"> • via spiracles and along {tracheae / tracheoles} by diffusion 	Allow trachea	(1)

Q24.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> oxygen used in respiration (1) oxygen in bubble may leave {by diffusion / down concentration gradient} (1) therefore bubble {becomes smaller / has less surface area} (1) therefore less oxygen can diffuse into bubble (1) oxygen will diffuse into bubble when there is less oxygen in bubble than in water (1) 		(3)

Q25.

Question Number	Answer	Additional Guidance	Mark
	Line drawn from left to right (over or between one lamellae) (1)		(1)

Q26.

Question Number	Answer	Additional Guidance	Mark
	A (0.4 s and 0.5 s)		(1)