

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 4: EXCHANGE AND TRANSPORT
GAS EXCHANGE

SCORE

/92

PERCENTAGE

%

STEMUP

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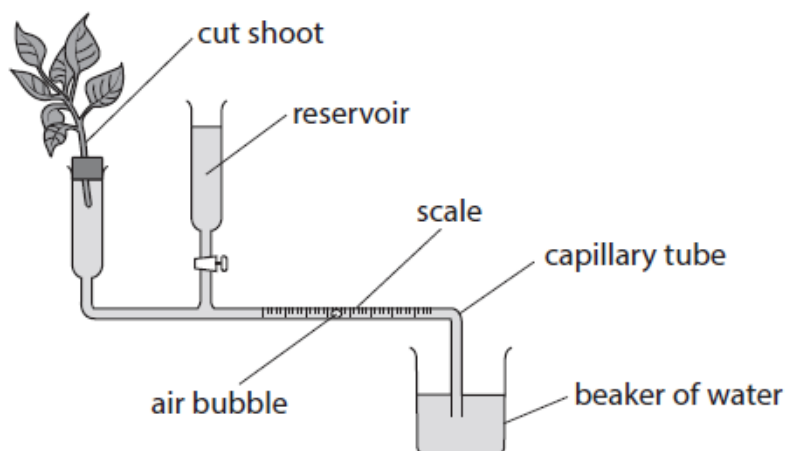
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Q1.

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.

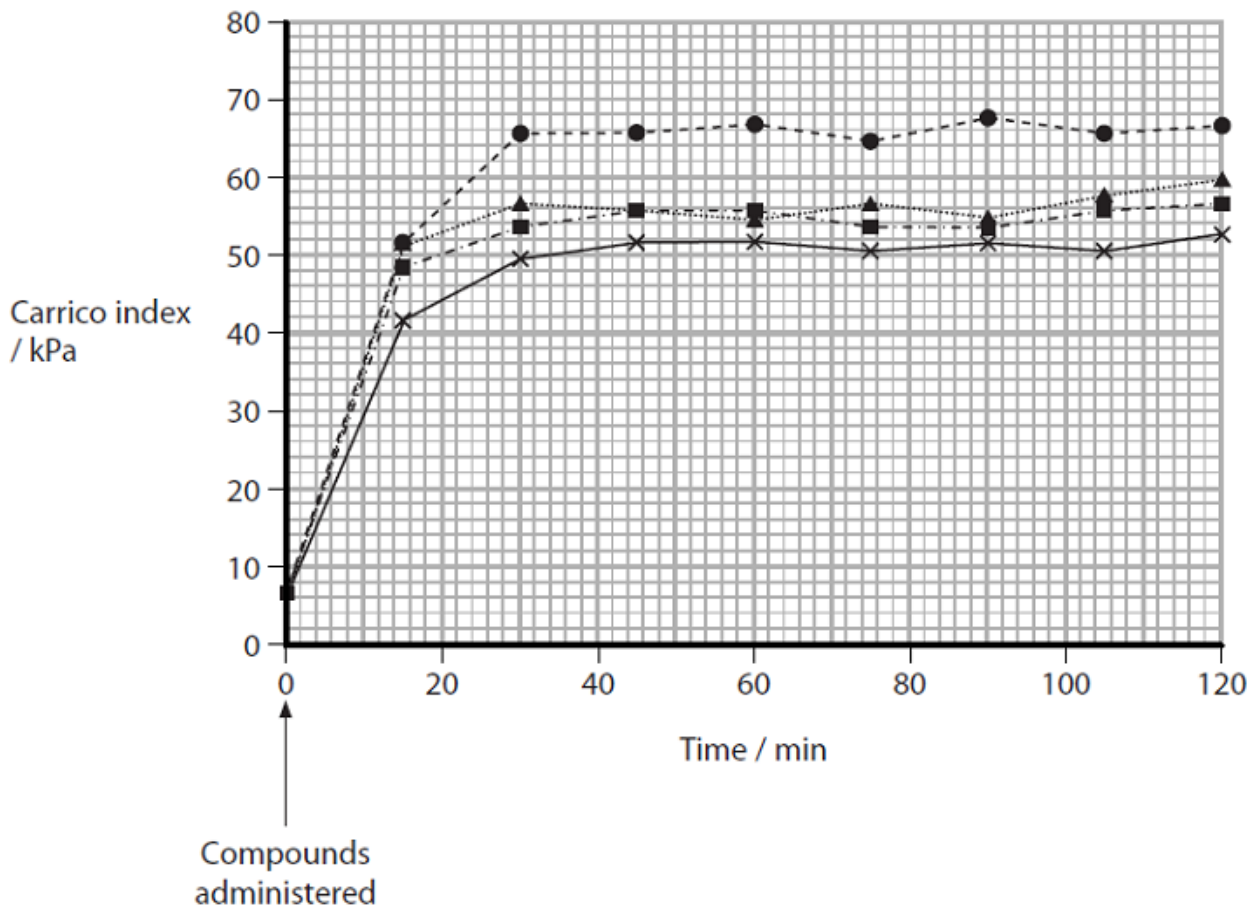
Each group of rabbits was given a different treatment.

- 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.

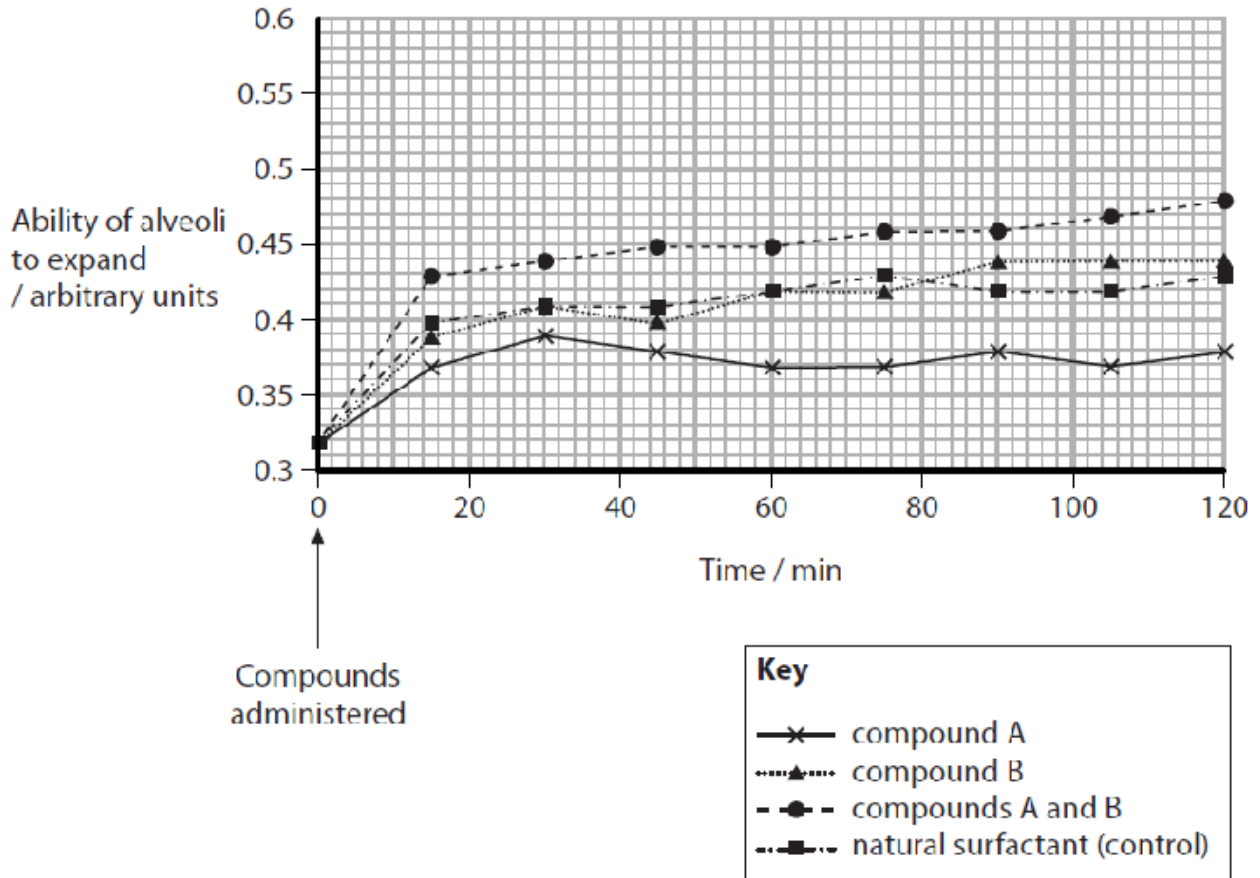
The mean Carrico index of each group of rabbits and the ability of the alveoli to expand were determined every 15 minutes.

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)

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(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.

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)

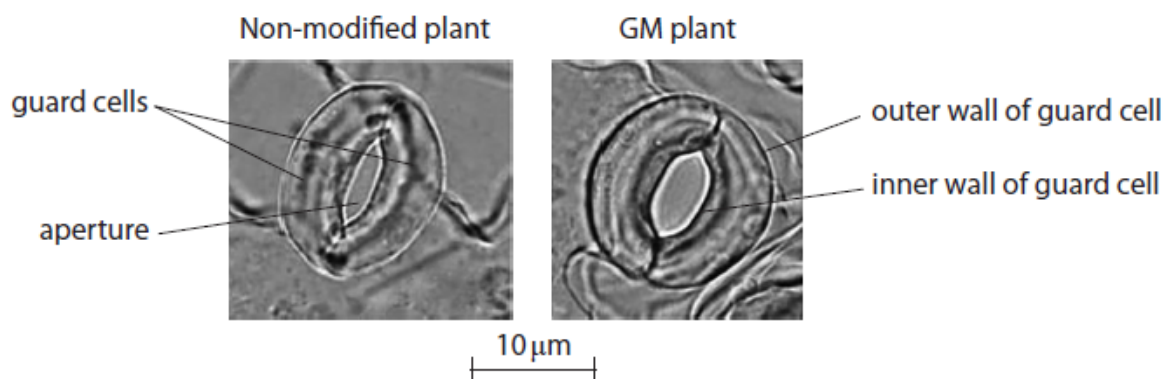
Q4.

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.

Hydrogen ions actively transported out of the guard cells



Potassium ions diffuse into the guard cells



Starch broken down into malate



Water moves into the guard cells



Aperture of the stoma widens

(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)

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(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 / $\text{cm}^3 \text{ kg}^{-1}$	Concentration of haemoglobin in blood / g dm^{-3}	Total blood volume / $\text{cm}^3 \text{ kg}^{-1}$	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)

[illegible]

(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)

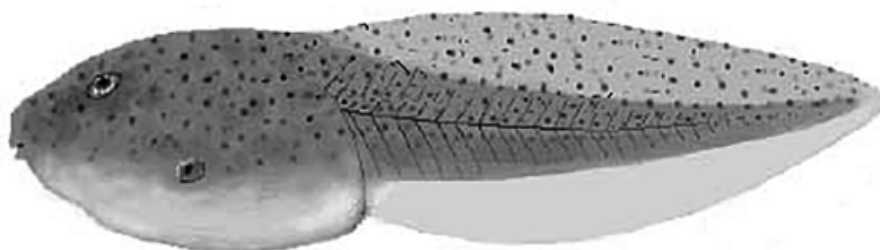
Q8.

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.

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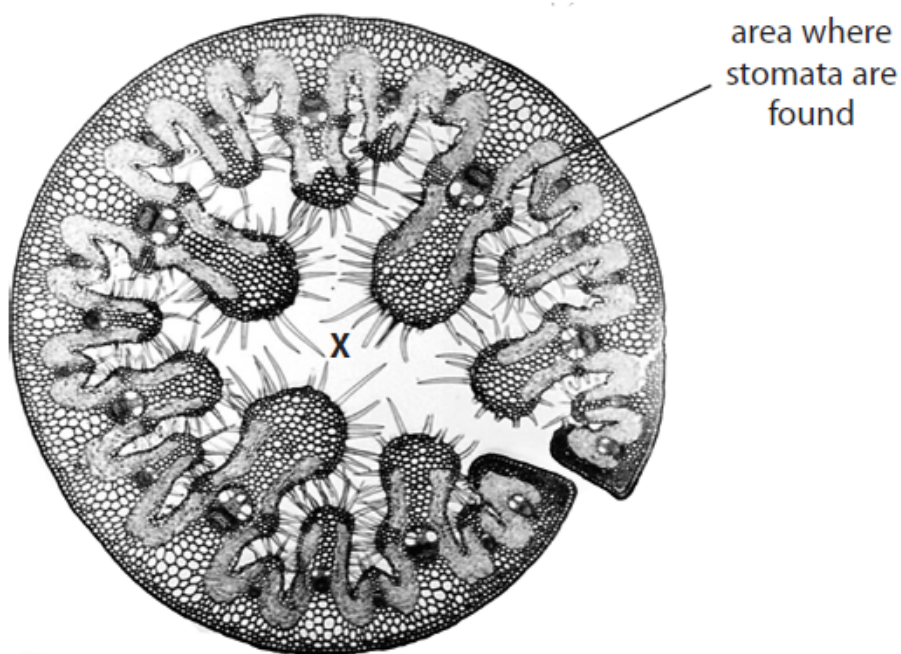
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(Total for question = 3 marks)

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.

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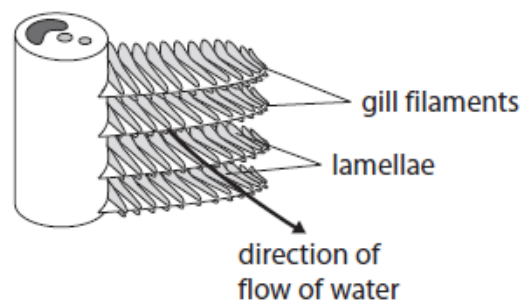
(Total for question = 3 marks)

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					
<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.

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(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 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)

Q12.

The photographs show leaves from six species of plant.



Daffodil



Frogbit floating on water



Sunflower



Maize



Oak tree

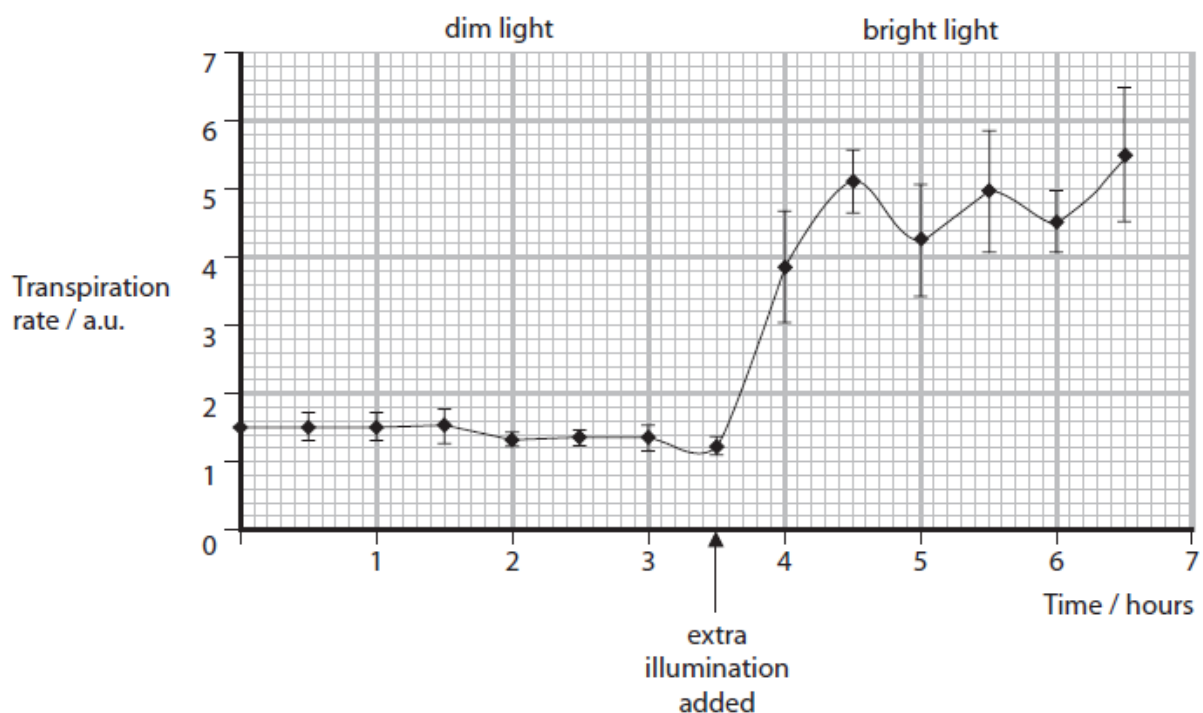


Pea

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)

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(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)

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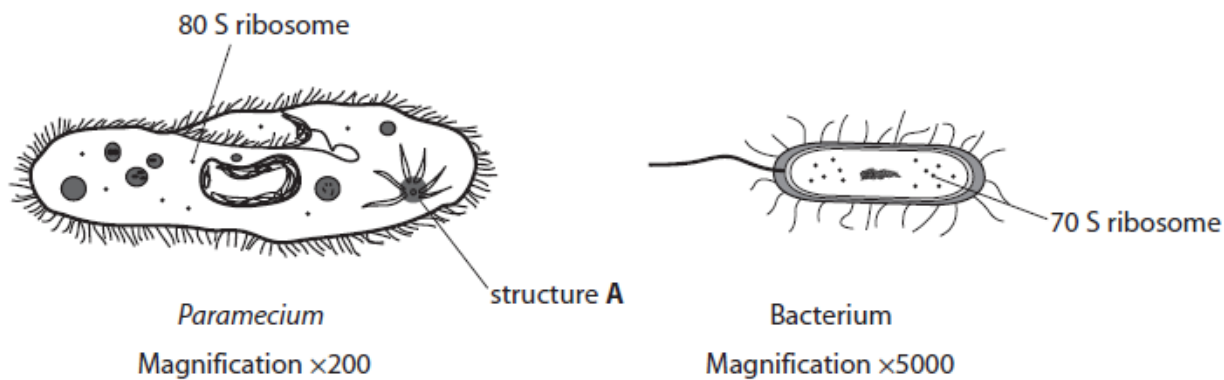
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(Total for question = 3 marks)

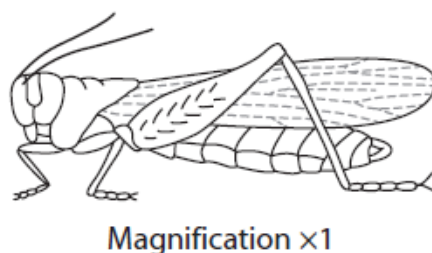
Q15.

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



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

The drawing shows a locust.



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

(2)

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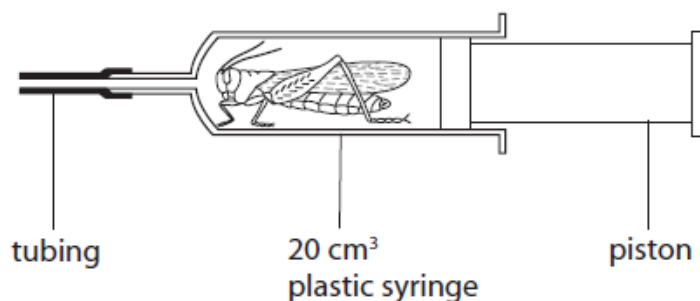
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(ii) A student placed a locust inside a transparent syringe and observed the movement of the abdomen.

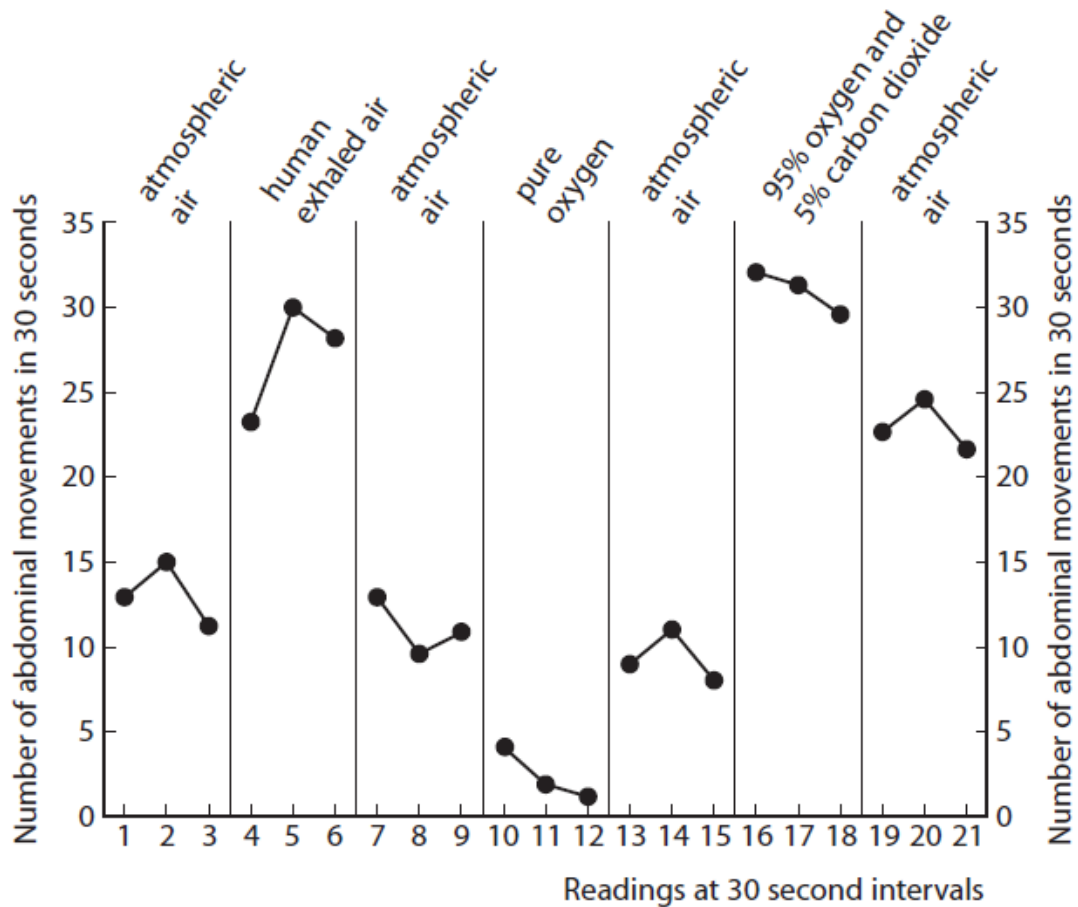


The student recorded the number of times the abdomen pumped in 30 seconds. This was carried out three times.

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.

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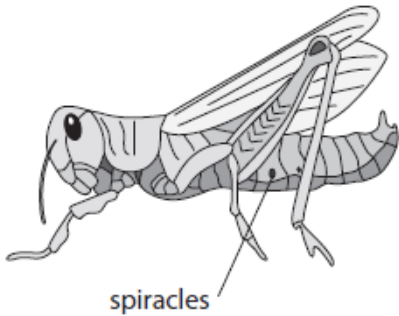
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Q16.

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)

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(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)

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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)

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.

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(Total for question = 6 marks)

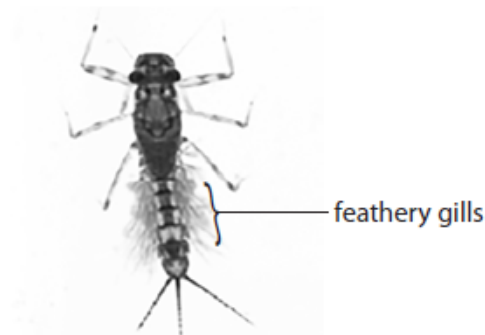
Q19.

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.

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(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	A calculation that shows the following stages • use manipulation of units to mm (1) • calculation of volume of cylinder (1) • rate per minute calculated to 2sf (1)	Example of calculation: eg mean is 64 (mm) 4.522 / 4.524 (this gets mp1 and 2 if 64 not seen) 45.2 is correct value if 6.4 is used 0.90 Correct answer with no working gains 3 marks 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)	Exp (3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that includes three of the following • {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)	Accept {water uptake / transpiration} is slowest in still air in the dark Not converse Accept concentration gradient / water potential gradient / diffusion shells around stomata or leaf Accept converse Accept stomata do not close completely until trial 3	Exp (3)

Question Number	Answer	Additional Guidance	Mark
(iv)	A description that includes four of the following: - 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)	Accept clear nail varnish / clingfilm Accept other times Accept time how long it takes to move a set distance Accept same number of leaves / similar surface area Accept calculate rate of water loss per unit area Piece together Accept eg. temperature – AC room / room temperature humidity – clear bag over plant light intensity – distance from lamp air movement – distance from fan Accept repeat and carry out appropriate stats test eg t-test, 95% confidence limits, Mann Whitney U test	Exp (4)

Q2.

Question Number	Indicative content
★	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. 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. Indicative content Descriptions (D) • 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 Analysis (A) • 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 Potential use (P) • 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	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. The explanation will contain basic information with some attempt made to link knowledge and understanding Only D
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure. D + A or D+ P
3	5-6	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. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. D+A+P

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	data correctly substituted into equation 14 / 14.1 / 14.07	<u>Example of calculation</u> (67 x 0.21 =) 14	1

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of the following: - 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	A is incorrect because ATP is broken down B is incorrect because ATP is broken down C is incorrect because condensation reactions form bonds	

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

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	A is incorrect because entry of water would make the cell more larger B is incorrect because entry of water would make the cell more larger C is incorrect because the stoma would not form if the inner wall was flexible	

Q5.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: - because 30 °C is an appropriate temperature for one species and provides enough oxygen for the other species (1) - because if the temperature was above {30 / 40} °C there would be less oxygen dissolved in it (1) - so there would not be enough oxygen for {respiration / metabolism / ATP production} (1) - because if the temperature was above {25 / 30} °C the enzymes would be denaturing (1) - because the temperature was below {25 / 30} °C the enzymes would not have enough {kinetic energy / collisions / enzyme substrate complexes} (1)	Accept because 30 °C satisfies the requirements of both fish Do not accept start to denature Accept for 1 mark 30 °C is close to the optimum temperature for the enzymes	(4)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	- total blood volume in one seal (1) - conversion of g dm^{-3} to g cm^{-3} (1) - total mass of haemoglobin (concentration of haemoglobin x volume of blood in a seal) (1)	<u>Example of calculation:</u> $400 \times 207 = 82800 \text{ cm}^3$ Accept calculation of total haemoglobin per $\text{cm}^3 \text{ kg}^{-1}$ blood: $207 \times 216 = 44712$ Accept calculation of concentration of haemoglobin in one seal: $216 \times 400 = 86400$ $216 \div 1000 = 0.216 \text{ g cm}^{-3}$ $0.216 \times 82800 = 17885 \text{ g}$ Correct answer with no working gains full marks Accept for two marks a correct answer with no units / wrong units Accept for three marks: $17884.8 \text{ g} / 17880 \text{ g} / 17890 \text{ g} / 17900 / 18000 \text{ g} / 17.8848 \text{ kg} / 17.885 \text{ kg} / 17.89 \text{ kg} / 17.9 \text{ kg} / 18 \text{ kg}$	(3)

Question Number	Indicative content
(ii) *	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. 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. <u>A: Depth and diving:</u> • positive correlation between maximum depth and maximum time holding breath • weak positive correlation between mass of animal and depth • weak correlation between maximum time holding breath and mass of mammal • because diving deeper requires larger oxygen storage as can't breathe underwater • aerobic respiration requires oxygen to release energy <u>B: Blood and muscle:</u> • positive correlation between volume of oxygen in body and maximum depth • positive correlation between concentration of haemoglobin in blood and maximum depth • no correlation between oxygen stored in muscle and maximum depth • all the mammals must possess myoglobin acting as an oxygen store in muscle • bottlenose dolphin and harbour seal have more oxygen stored in lungs / Weddell seal and Northern elephant seal have less oxygen stored in lungs • oxygen stored in lungs results in more buoyancy so deeper diving mammals have less stored in lungs • combined effect of high blood volume and haemoglobin concentration results in very high blood oxygen storage • more oxygen stored in blood so higher haemoglobin concentration and blood volume in animals that dive deeper • all have similar proportions of oxygen stored in muscle <u>Quantitative analysis</u> • Q1: quoting of data to support explanation • Q2: manipulation of data to support explanation, for example, determining total haemoglobin concentrations in mammals.

Level	Marks	
0	0	No awardable content
1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. Level 1: Description of some patterns from at least one of A or B
2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. The discussion shows some linkages and lines of scientific reasoning with some structure. Level 2: Description of patterns with explanation from at least one of A or B
3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. Level 3: Detailed description and explanation of patterns from both A and B with quantitative analysis (Q)

Q7.

Question Number	Answer	Mark
(i)	The only correct answer is C hydrogen <i>A is incorrect because covalent bonds do not form between neighbouring water molecules</i> <i>B is incorrect because ionic bonds do not form between neighbouring water molecules</i> <i>D is not correct because hydrophobic bonds do not form between neighbouring water molecules</i>	1

Question Number	Answer	Mark
(ii)	The only correct answer is C three <i>A is incorrect because there are three components</i> <i>B is incorrect because there are three components</i> <i>D is incorrect because amino acids are not a component</i>	1

Q8.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • 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)

Q9.

Question Number	Answer	Mark
	An explanation that makes reference to three of the following: • 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)

Q10.

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)	<u>Indicative content</u> Gill filaments: - 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 Lamellae: - 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 area 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 have a smaller diffusion distance - but no obvious correlation with activity or mass Explanations: - higher {number of filaments / lamellae / surface area} increases gas exchange - a smaller diffusion increases gas exchange	Level 1: 1 mark = one gill aspect commented on 2 marks = two gill aspects commented on Level 2: 3 marks = two gill aspects commented on with an explanation 4 marks = three gill aspects commented on with an explanation Level 3: 5 marks = four gill aspects commented on, with an explanation 6 marks = four gill aspects commented on, with an explanation linking to muscle contraction	6 EXP

	- 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		
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Q11.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to five of the following: - carbon dioxide is absorbed through the stomata and water is lost (1) - recognition of two patterns of stomatal distribution (1) Trees (beech, oak, sycamore) plus pea & sunflower - plants {with leaves lying flat / have most stomata on the lower surface} to reduce water loss from direct sunlight (1) Frogbit {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) Daffodil & maize - leaves are {upright / exposed to equal amounts of light} so have stomata on both surfaces (1)	Allow {more on upper / more on lower / equal distribution} Allow stomata on lower surface allow {carbon dioxide to enter / gas exchange} Allow it needs to absorb carbon dioxide from the air	(5)

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: - rate at low light intensity and high light intensity estimated (1) - percentage increase calculated (1)	Acceptable range of rates 1.2 to 1.5 4.5 to 5.5 Acceptable range = 200 – 358% Correct answer with no working gains full marks	(2)
(ii)	An explanation that makes reference to the following: - temperature because it affects the rate of transpiration (1) - humidity because it affects the rate of transpiration (1)	accept other relevant factors eg. windspeed availability of water	(2)

Q13.

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

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

Q14.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: - enters through spiracles (1) - diffusion {in tracheae / in tracheoles / into cells} (1) - down concentration gradient (1)		(3)

Q15.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - locust has a smaller surface area to volume ratio than <i>Paramecium</i> (1) - therefore has { tracheae / tracheoles } to provide greater surface area (for gas exchange / diffusion) (1)	Allow converse statements	(2)

Question Number	Indicative content	
(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. 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. • in human exhaled air abdominal pumping movements rise, but since exhaled air is warmer / more moist, contains more carbon dioxide and less oxygen than atmospheric air no conclusion can be reached from this result • in the presence of pure oxygen the number of abdominal pumping movements is lower than when in atmospheric air • in the presence of pure carbon dioxide the number of abdominal pumping movements is higher than when in atmospheric air • in atmospheric air there is some residual effect of previous gas exposure	
Level	Mark	Descriptor
	0	No awardable content
1	1-2	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. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.

2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.
3	5-6	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. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • {supply / store of / reservoir of} oxygen (1) • so respiration can occur in {large / active} locusts (1)		(2)

Q17.

Question Number	Answer	Additional Guidance	Mark
(i)	• insect weighed before and after investigation and the difference calculated (1)		(1) GRAD

Question Number	Answer	Additional Guidance	Mark
(ii)	• 42.86 (%)	DO NOT ACCEPT 42.860 or any other numbers	(1) CLER

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: • 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)	ACCEPT a description e.g. so that the effects of lower humidities can be seen ACCEPT reduce water loss so there will be water in the tracheoles IGNORE water enters spiracles ACCEPT higher humidities might be harmful	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to three of the following: • 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)	ACCEPT converse where appropriate ACCEPT fewer water molecules in air / down a (water vapour) concentration gradient (into air) ACCEPT breathing rate / gas exchange	(3) EXP

Q18.

Question Number	Answer	Mark
(i)	The only correct answer is B <i>A is not correct because chi squared test compares expected result to the actual result</i> <i>C is not correct because standard deviation measures scatter about the mean</i> <i>D is not correct because Student's t test compares the means of two sets of data</i>	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	• $6\sum d^2$ calculated (1) • $n(n^2-1)$ calculated (1) • correct r_s value given (1)	<u>Example of calculation</u> $6 \times 108 = 648$ $7(49-1) = 336$ $1 - (648 \div 336) = -0.93 / 0.93 / -0.929 / 0.929$ Accept ecf from $6\sum d^2$ and $n(n^2-1)$ calculations Correct answer gains full marks, with no working shown	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - critical value found at {$p = 0.05$ / 95% level confidence level / 5% significance level} (1) - because if {calculated / r_s} value is greater than critical value there is a {strong / significant} {relationship / correlation} (1)	Accept 0.01 / 99 % Accept converse	(2)

Q19.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to three of the following: Similarities: - large surface area (1) - thin exchange surface / small diffusion distances (1) Differences: - nymphs have gills and adults have trachea / spiracles (1) - the nymph has external system and the adult has internal system (1)	DO NOT PIECE TOGETHER ACCEPT both have tracheoles if not awarded as a difference ACCEPT tracheoles if not awarded as a similarity ACCEPT gills on the outside and {spiracles / trachea / tracheoles} are on the inside	(3)