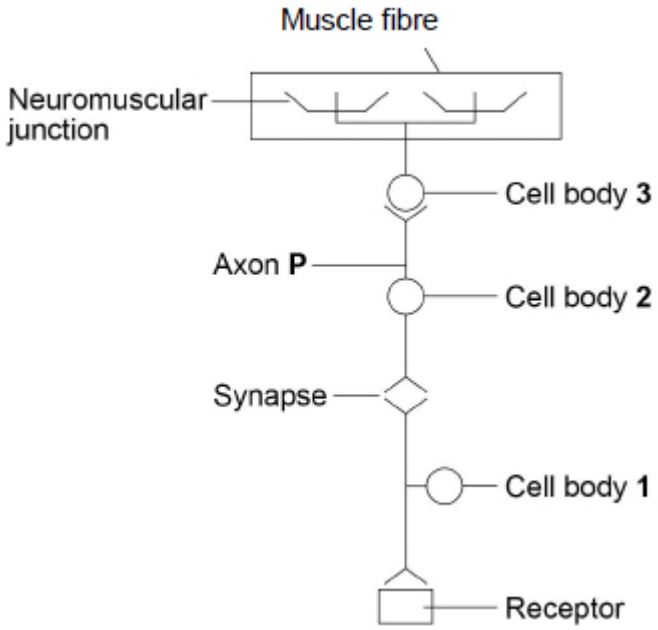
6.1 Organisms – Responses to their environment (A-Level Only) - Survival and response – Questions

Q1.

The diagram below shows a nerve pathway in an animal.



(a) The nerve pathway shown in the diagram may be regarded as a simple reflex arc.

Use the diagram to explain why.

_____

_____

_____

(1)

(b) Suggest **two** advantages of simple reflexes.

1. _____

_____

_____

2. _____

_____

_____

(2)

(c) In the nerve pathway in the diagram, synapses ensure that nerve impulses only travel towards the muscle fibre.

Explain how.

_____

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(2)

(d) Axon **P** was found to conduct impulses much faster than other axons in the nerve pathway shown in the diagram.

Describe and explain **one** feature of axon **P** that might cause this difference.

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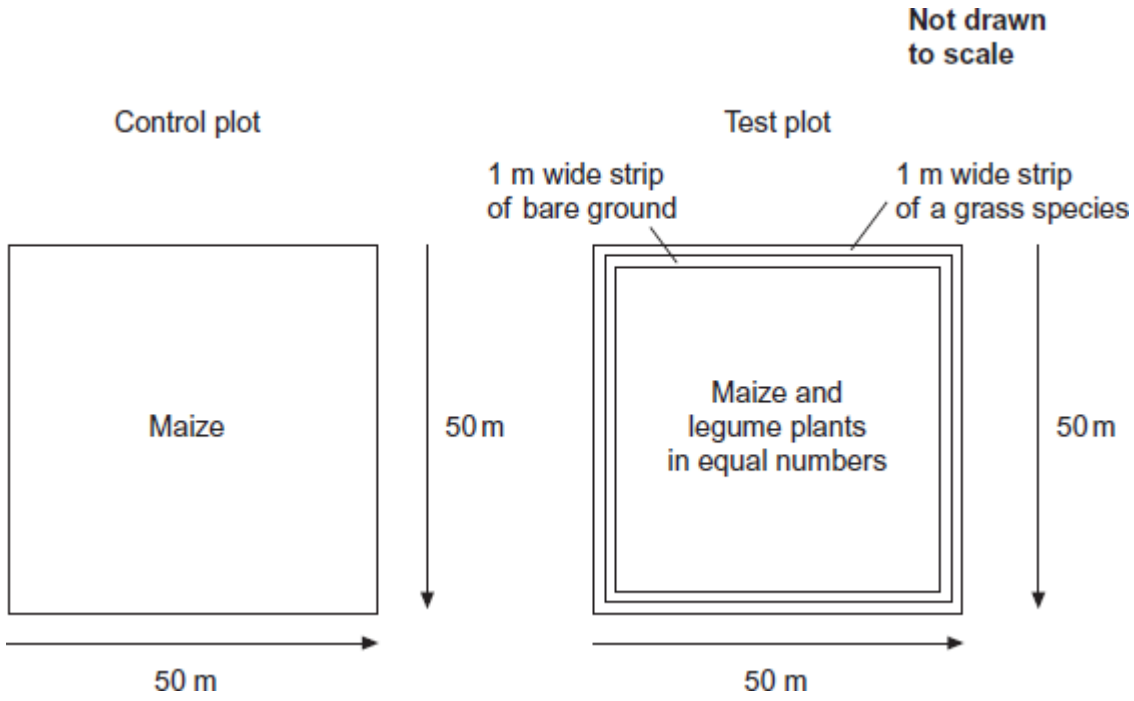
(2)

(Total 7 marks)

Q2.

Stemborers are insect pests that feed on maize plants. Scientists investigated the effect of **push-pull** stimuli on the control of these pests.

For this investigation, the scientists divided a large field into plots measuring 50 m × 50 m. They then designated each plot as a control plot or a test plot. The following figure shows what they planted in each type of plot.



The legumes planted with the maize drive stemborers away.
The grass species attracts stemborers.

The table below shows the scientists' results.

Plots	**Mean percentage damage to maize plants**	**Mean maize grain yield / tonnes per hectare (± standard deviation)**	**Mean production costs per farmer / $ per hectare (± standard deviation)**	**Mean total income for farmer / $ per hectare (± standard deviation)**
Control	29.6	1.5 (±0.2)	250 (±0.7)	329 (±5.9)
Test	6.7	3.7 (±0.3)	278 (±1.1)	679 (±10.2)

(a) In the test plot of land, identify the push stimulus and the pull stimulus.

Push stimulus _____

Pull stimulus _____

(1)

(b) When measuring the mean percentage damage to maize plants, 60 plants from each test plot were selected at random and examined.
Describe how the maize plants could be selected at random.

_____

_____

_____

(Extra space) _____

(3)

(c) In the test plot, bare ground was left between the maize and the grass species.
Suggest an explanation why.

(2)

(d) The legume plants have nodules containing nitrogen-fixing bacteria on their roots.
Explain how nitrogen-fixing bacteria could increase the growth of the maize.

(2)

(e) A year after this investigation, the government of one country decided that their farmers should use these **push-pull** stimuli.
How do these data support this decision?

(Extra space) _____

_____

_____

(3)

(Total 11 marks)

Q3.

(a) Give **one** similarity and **one** difference between a taxis and a tropism.

Similarity _____

_____

_____

Difference _____

_____

_____

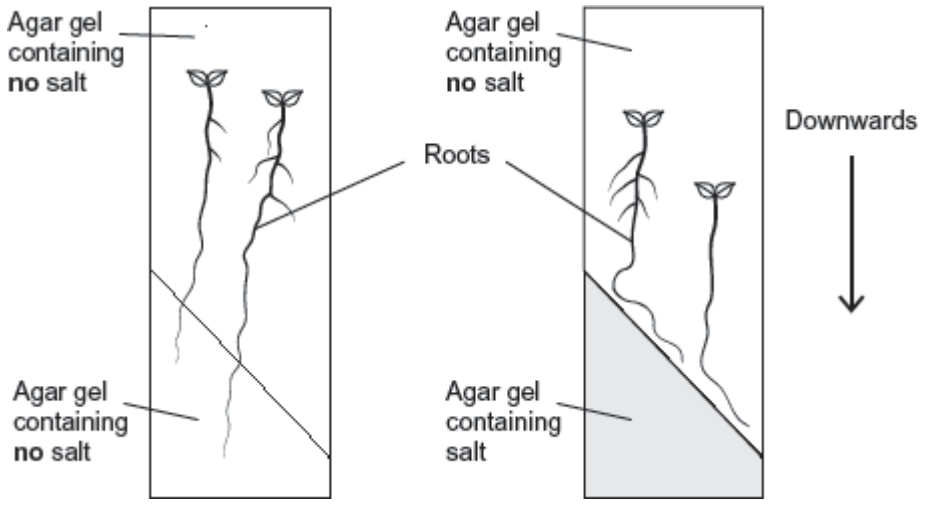
(2)

Scientists investigated tropisms in the roots of tomato plants. They grew tomato plants from seeds on vertical agar plates, as shown in **Figure 1**. The top of each plate was made of agar gel containing **no** salt. The bottom of each plate was made of one of the following:

- agar gel containing **no** salt
- agar gel containing salt.

Typical results for growth of the roots are shown in **Figure 1**.

Figure 1



(b) What do these results show about the responses of the roots of tomato plants to gravity and salt?

_____

_____

[Extra space] _____

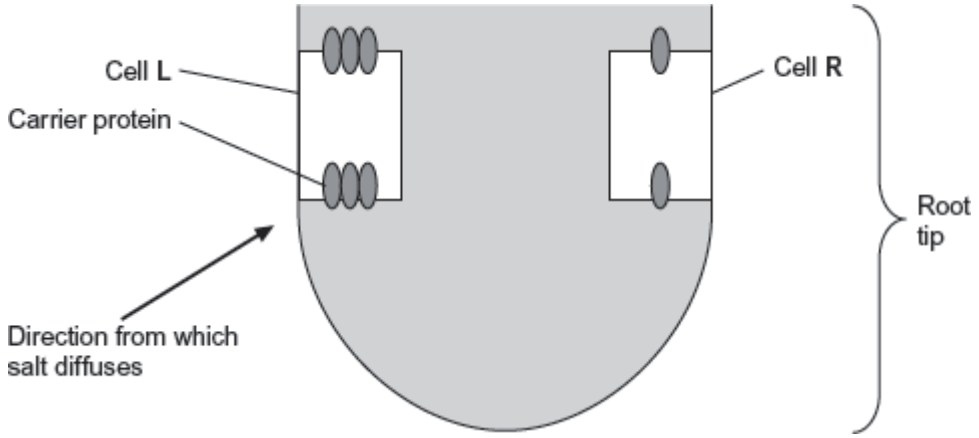
(3)

(c) In root tips of tomatoes, IAA is transported **out** of the cells by a carrier protein. In roots of tomatoes, high concentrations of IAA inhibit cell elongation.

The scientists' hypothesis was that salt causes a change in the number of IAA carrier proteins in cells in different parts of the root tip.

Figure 2 shows two cells, **L** and **R**, in the root tip of a tomato plant.

Figure 2



Explain why this root tip would grow away from salt.

[Extra space] _____

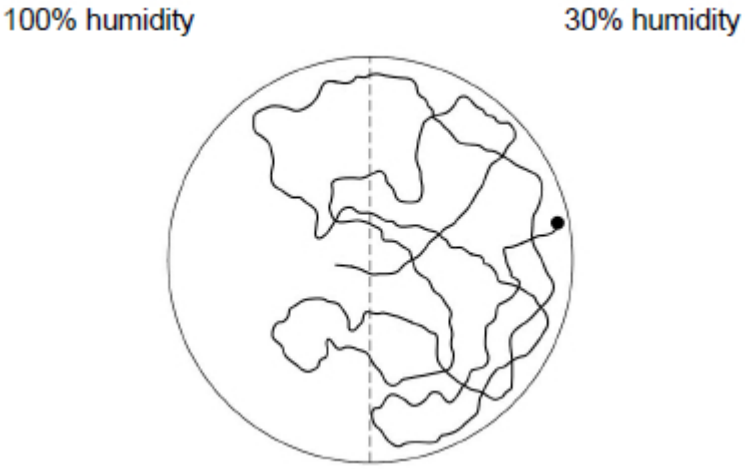
(3)
(Total 8 marks)

Q4.

Scientists investigated the effect of humidity on the movement of the insect, *Tenebrio molitor*.
The insects were placed in choice chambers with one side kept at 100% humidity and the other side kept at 30% humidity.
The insects were used one at a time and the path the insect followed recorded on paper.

Figure 1 shows a typical result. The solid dot shows the final recorded position of the insect.

Figure 1



(a) What type of behaviour was shown by the insect in **Figure 1**?

Give evidence from **Figure 1** to support your answer.

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_____

(2)

(b) The scientists found that the insects moved for 94% of the time in the more humid side, but in the drier side they moved only 20% of the time. The scientists concluded that reduced movement in the drier side was an adaptation that reduced water loss.

Use your knowledge of gas exchange in insects to explain how this behaviour would reduce water loss in the insects.

_____

_____

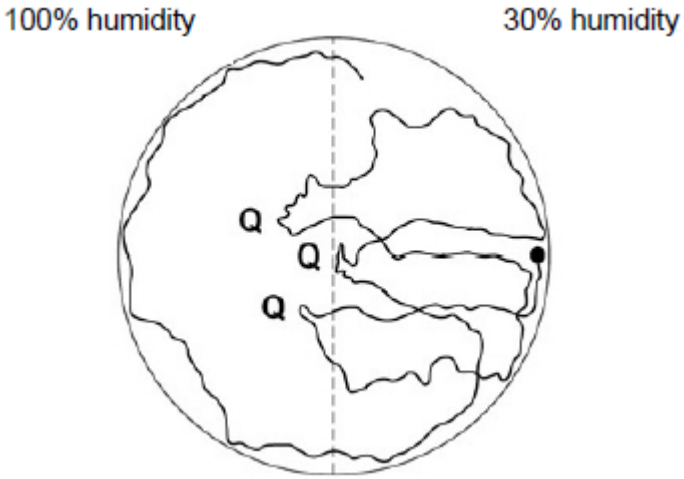
(2)

(c) *Tenebrio molitor* has two antennae on its head. These are sense organs.

The scientists found that one insect stopped when it reached the boundary between the two sides of the choice chamber and seemed to perform various movements with its antennae. The insect then moved to the drier side.

This behaviour can be seen in **Figure 2**. The points marked with a **Q** indicate where the insect showed this behaviour.

Figure 2



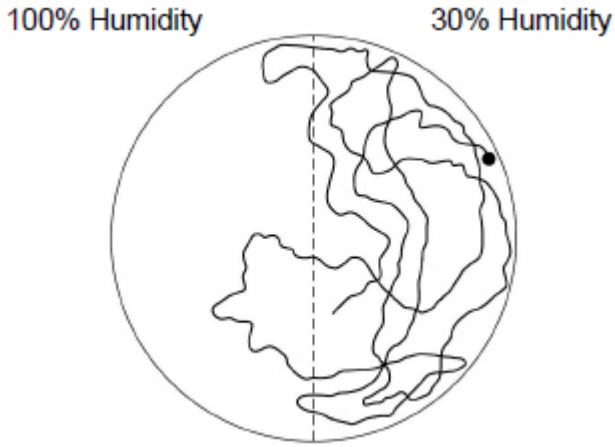
What type of behaviour did the scientists conclude that the insect in **Figure 2** was showing?

(1)

(d) After observing the behaviour of the insect in **Figure 2**, the scientists hypothesised that if an insect had one of its antennae removed it would have a tendency to turn to one side and move in circles. The scientists tested this hypothesis by cutting one antenna off another insect and observing its movement.

The result of this experiment can be seen in **Figure 3**.

Figure 3



Does the movement observed in **Figure 3** support the scientists' hypothesis?
Give the reason for your answer.

_____

_____

_____

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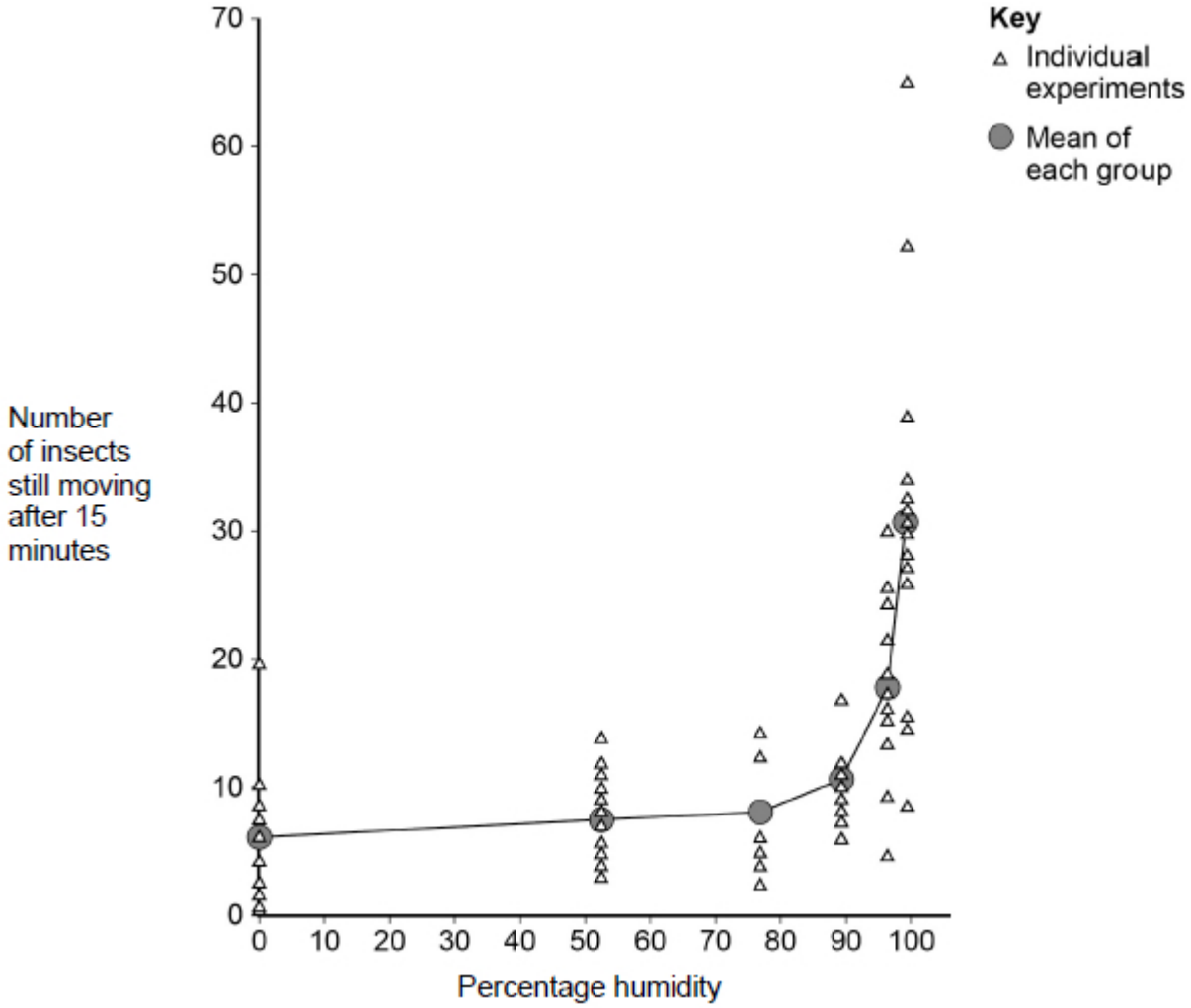
(2)

(e) The scientists then investigated the effect of a range of humidities on the activity of the insects. **Figure 4** shows their results. The triangles represent the number of insects still moving after 15 minutes.

Figure 4



A student studying **Figure 4** concluded that as humidity increases, so does movement of the insects.

Evaluate the student's conclusion.

_____

_____

_____

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_____

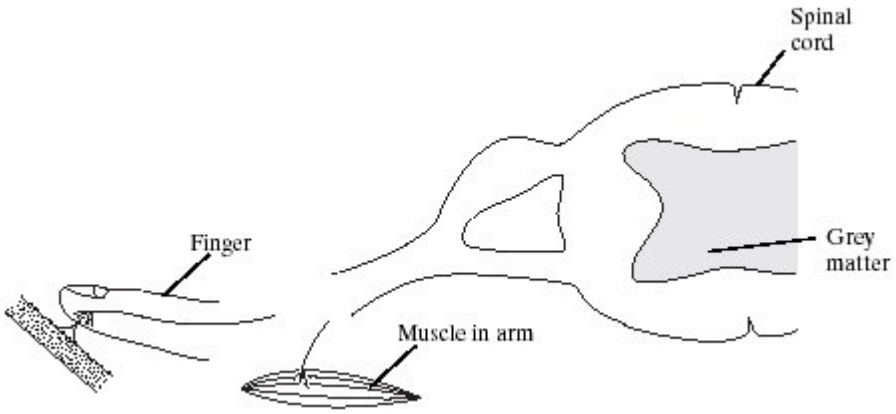
(2)

(Total 9 marks)

Q5.

A gardener accidentally pricks a finger on a thorn. She quickly pulls the finger away. This reaction results from a simple reflex arc involving three neurones.

The diagram shows part of the pathway involved in this reaction.



(i) Complete the diagram to show the rest of the simple reflex arc.

(1)

On your diagram

(ii) name and label the **three** neurones;

(iii) label the effector.

(2)

(Total 3 marks)

Q6.

A biologist investigated the behaviour of a species of worm that lives in soil.

He cultured three samples of worms in three separate trays of soil for many days. Each culture:

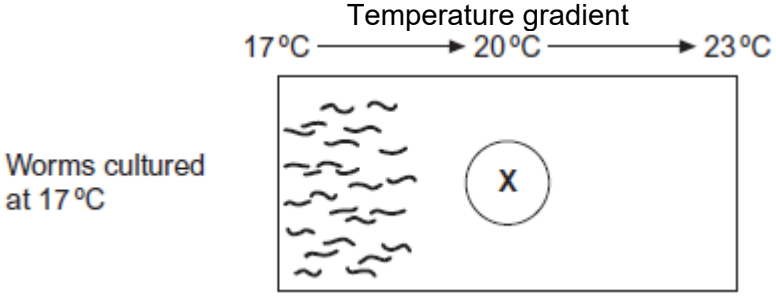
- contained a food supply
- was kept at a different temperature.

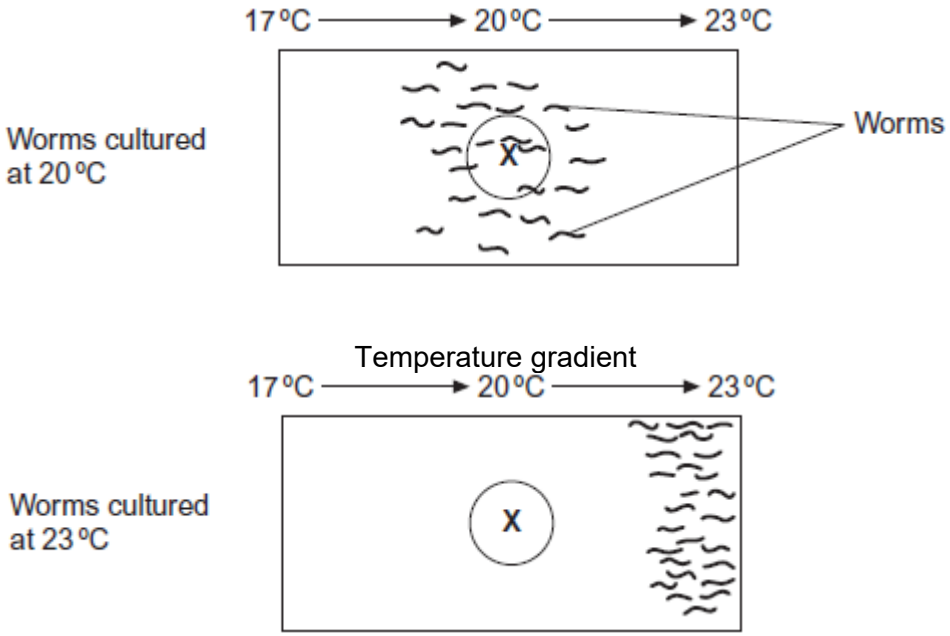
The temperatures of the cultures were 17 °C, 20 °C and 23 °C.

The biologist then removed food from the trays for several hours. Then he transferred each sample of worms onto a glass surface where there was **no food**. Each surface had a temperature gradient across it. After 1 hour, the biologist recorded the position of each worm.

The figure below shows his results. On each diagram, 

marks where he released the worms onto the glass surface.





(a) The biologist concluded that the worms' behaviour demonstrated taxis. How do these results support this conclusion?

(2)

(b) Using the information provided, suggest an explanation for the worms' behaviour on the glass surfaces in the absence of food.

(Extra space)

(3)

(c) In each experiment, the biologist exposed the surfaces to light that was dim and even, so he could see where the worms went.

Apart from seeing where the worms went, suggest **two** reasons why it was

important that the light was dim and even.

1. _____

_____

2. _____

_____

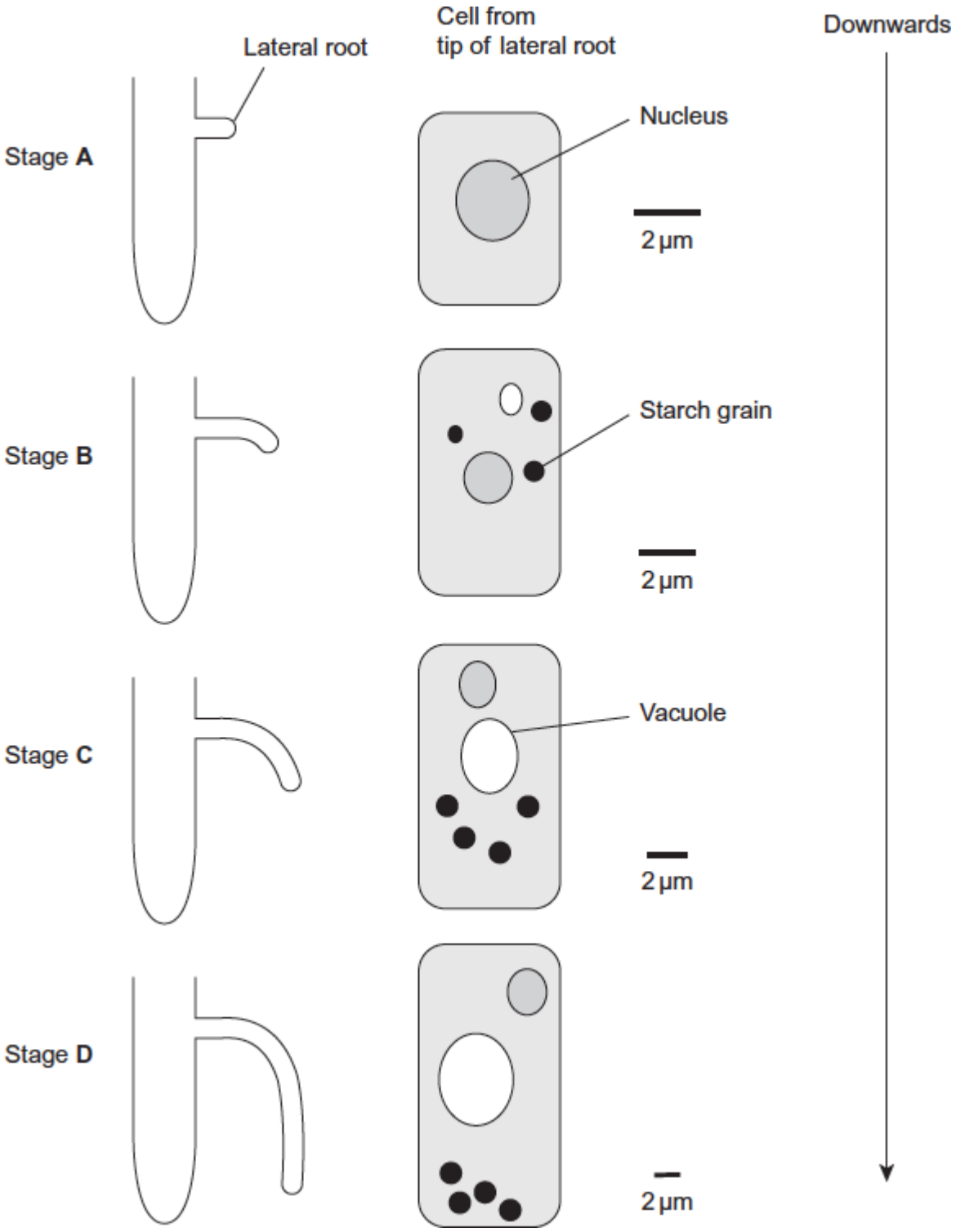
(2)

(Total 7 marks)

Q7.

Scientists investigated the response of lateral roots to gravity. Lateral roots grow from the side of main roots.

The diagrams show four stages, **A** to **D**, in the growth of a lateral root and typical cells from the tip of the lateral root in each stage. All of the cells are drawn with the bottom of the cell towards the bottom of the page.



(a) Describe **three** changes in the root tip cells between stages **A** and **D.**

1. _____

_____

2. _____

_____

3. _____

(3)

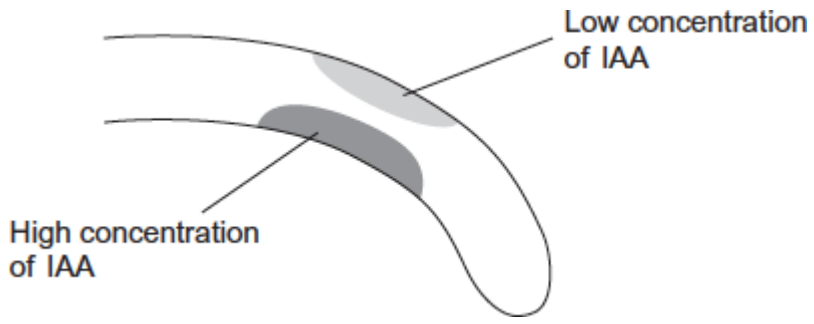
(b) The scientists' hypothesis was that there was a relationship between the starch grains in the root tip cells and the bending and direction of growth of lateral roots.

Does the information in the diagram support this hypothesis? Give reasons for your answer.

(Extra space)

(3)

(c) The diagram shows the distribution of indoleacetic acid (IAA) in the lateral root at Stage **B.**



Explain how this distribution of IAA causes the root to bend.

(2)

(Total 8 marks)

Q8.

Scientists investigated the response of the roots of pea seedlings to gravity.

They took three samples of seedlings, **A**, **B**, and **C**, and placed them so that their roots were growing horizontally. The root tips of each sample had been given different treatments. After a set time, the scientists recorded whether the roots of the seedlings had grown upwards or downwards and the amount of curvature. The table shows the treatment they gave to each sample and their results.

Treatment	**Results**	
	Direction of growth	**Mean amount of curvature / degrees**
A None 	Downwards	60
B Root tip removed 	Continues to grow horizontally	0
C Upper half of root tip removed 	Downwards	30

(a) The pea seedlings were kept in the dark after each treatment. Explain why this was necessary.

_____

_____

_____

(1)

(b) What conclusion can be made from the results for treatment **B**?

_____

_____

_____

(1)

(c) Suggest how indoleacetic acid (IAA) could have caused the results for

(i) treatment **A**

(2)

(ii) treatment **C**.

(2)

(Total 6 marks)

Q9.

IAA is a specific growth factor.

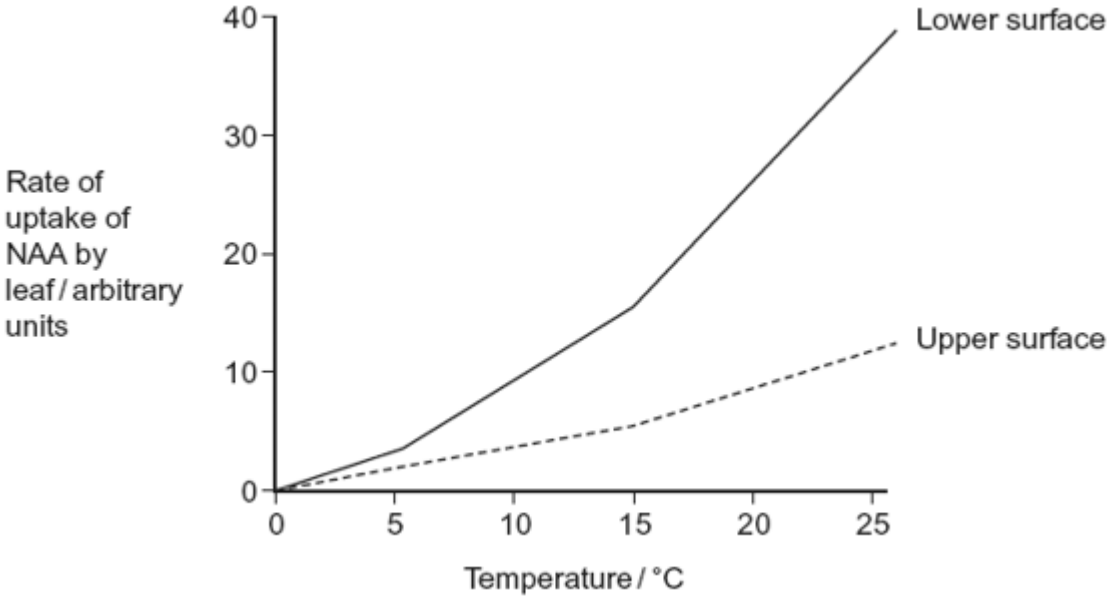
(a) Name the process by which IAA moves from the growing regions of a plant shoot to other tissues.

(1)

(b) When a young shoot is illuminated from one side, IAA stimulates growth on the shaded side. Explain why growth on the shaded side helps to maintain the leaves in a favourable environment.

(2)

NAA is a similar substance to IAA. It is used to control the growth of cultivated plants. Plant physiologists investigated the effect of temperature on the uptake of NAA by leaves. They sprayed a solution containing NAA on the upper and lower surfaces of a leaf. The graph shows their results.



(c) Explain the effect of temperature on the rate at which NAA is taken up by the lower surface of the leaf.

(2)

(d) There are differences in the properties of the cuticle on the upper and lower surfaces of leaves.

(i) Suggest how these differences in the cuticle might explain the differences in rates of uptake of NAA by the two surfaces.

(2)

(ii) In this investigation, the physiologists investigated the leaves of pear trees.

Explain why the results might be different for other species.

_____

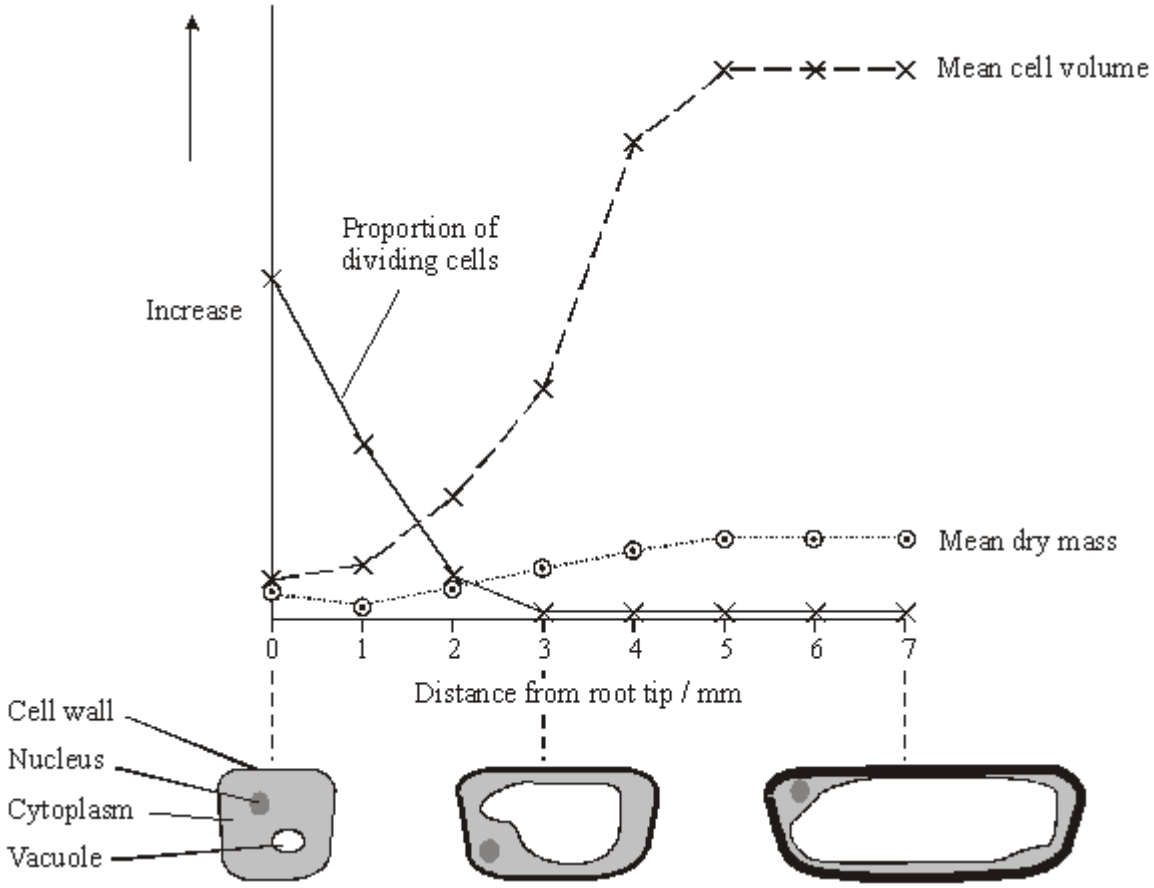
(1)

(Total 8 marks)

Q10.

A large number of roots from many genetically identical bean plants were cut into short pieces. The pieces were sorted into groups, depending upon their distance from the root tip. Some pieces from each group were used to find the mean dry mass of their cells. Thin sections cut from other pieces were examined with a light microscope to find the proportion of dividing cells and the mean volume of the cells.

The graph shows the results. The diagrams below the graph show the appearance of cells in light microscope sections at different distances from the root tip.



(a) Suggest **two** variables, other than genotype, which need to be controlled to ensure similar root growth in different plants. In each case give the reason for your answer.

1. _____

_____

_____

2. _____

_____

(2)

(b) Suggest how the proportion of dividing cells in a thin section could be determined.

(2)

(c) Explain the change in the proportion of dividing cells with increasing distance from the root tip.

(2)

(d) Using the graph and diagrams, suggest how a root tip gets longer.

(3)

(Total 9 marks)

Q11.

Plant physiologists attempted to produce papaya plants using tissue culture. They investigated the effects of different concentrations of two plant growth factors on small pieces of the stem tip from a papaya plant. Their results are shown in the table.

Concentration of auxin / μmol dm^{-3}	**Concentration of cytokinin / μmol dm^{-3}**		
	5	25	50

0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

Callus is a mass of undifferentiated plant cells. Plantlets are small plants.

(a) Explain the evidence from the table that cells from the stem tip are totipotent.

_____

_____

_____

_____

_____

(2)

(b) Calculate the ratio of cytokinin : auxin that you would recommend to grow papaya plants by this method.

Answer _____

(2)

(c) (i) Papaya plants reproduce sexually by means of seeds. Papaya plants grown from seeds are very variable in their yield. Explain why.

_____

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_____

_____

_____

(2)

(ii) Explain the advantage of growing papaya plants from tissue culture rather than from seeds.

_____

_____

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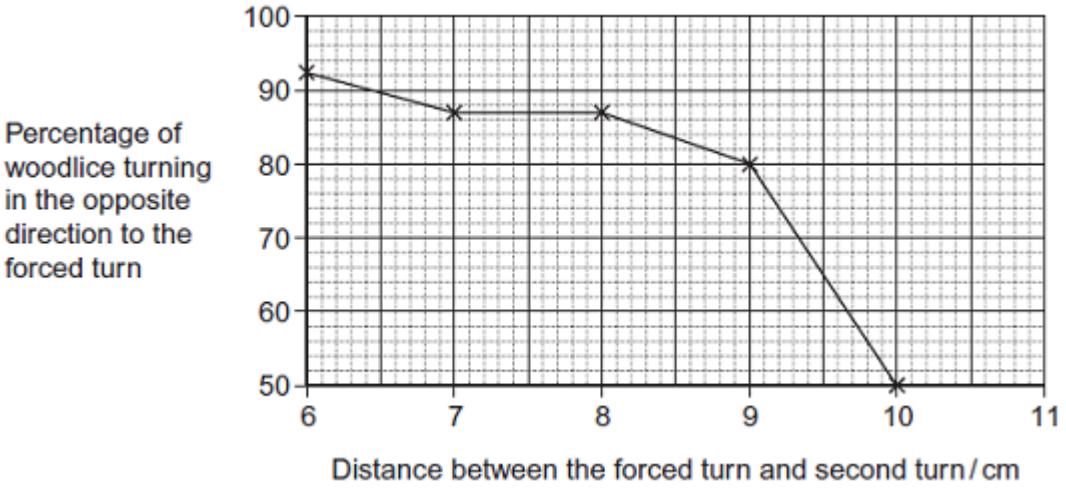
(1)

(Total 7 marks)

Q12.

A student investigated the effect of distance from a forced turn on the direction woodlice turned when next given a choice. The following figure shows her results.



(a) Describe the response of woodlice to increased distance between turns.

_____

_____

_____

_____

_____

(2)

(b) Can you conclude that woodlice show turn alternation behaviour when the distance between the forced turn and the second turn was 10 cm?
Explain your answer.

_____

_____

_____

_____

(2)

(c) The student suggested that the difference in turning behaviour of the woodlice in her investigation was due to the distance between the first and second turn. Her friend suggested that it was due to the time taken to get from the first to the second turn and **not** the distance. Suggest how you could investigate which of these two possibilities is more likely.

(Extra space)

(3)

(d) Woodlice usually live in areas where stones and twigs form obstacles. Obstacles in the path of woodlice cause them to make forced turns. The more obstacles there are in the path, the shorter the distance between the forced turns.

Use the data in the figure above to explain how the behaviour of woodlice results in them moving rapidly out of unfavourable areas.

(2)

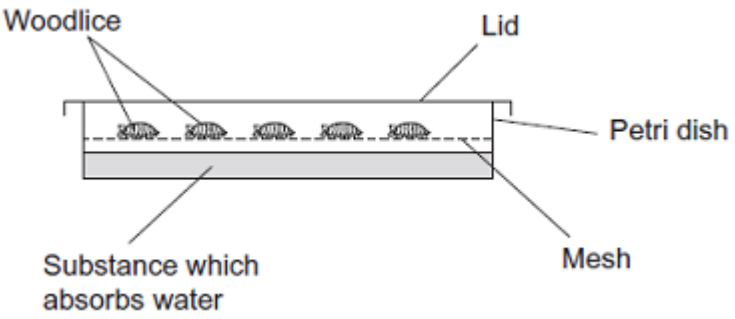
(Total 9 marks)

Q13.

Scientists investigated the effect of relative humidity on the activity of woodlice. They set up a Petri dish as shown in **Figure 1**.

In the bottom half they put a substance which absorbs water. Different concentrations of this substance produced different humidities in the air above the mesh.

Figure 1

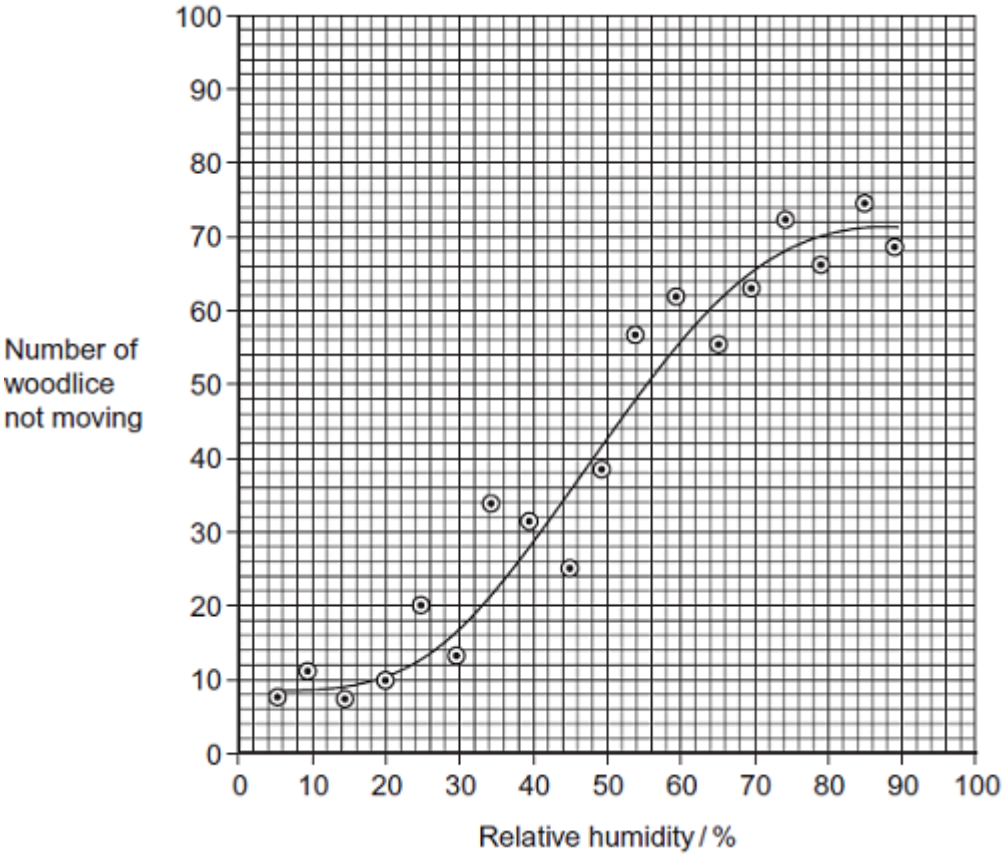


The scientists

- placed 10 woodlice in the top half of the dish
- replaced the lid and left the apparatus for 15 minutes in the laboratory
- recorded the number of woodlice **not** moving during the next 30 seconds
- repeated the experiment to obtain data for 100 woodlice
- repeated the experiment at different humidities.

The results are shown in **Figure 2**.

Figure 2



(a) The woodlice were left for 15 minutes before their movement was recorded. Give **two** reasons for this.

1. _____

_____

2. _____

(2)

(b) It is **not** possible to conclude that the change in the behaviour of the woodlice shown in **Figure 2** is caused by changes in humidity. Explain why.

(2)

(c) The points in **Figure 2** do not all fall on the curve. Suggest why.

(Extra space)

(3)

(Total 7 marks)

Q14.

Woodlice use gills for gas exchange. These gills are situated on the outside of the animal so water loss occurs from the gill surface. When a number of woodlice occur together they often form a 'clump' with individual woodlice touching each other.

A student investigated the effect of clumping on the rate of water loss from the woodlice. The student divided the 12 woodlice into two groups. He allowed the woodlice in group A to clump together, but kept the woodlice in group B separate from each other.
The following table shows the mean mass of the woodlice in each group.

Time / minutes	**Mean mass of woodlice / g**	
	Group **A**	Group **B**
0	0.180	0.175

20	0.170	0.130
40	0.165	0.110
60	0.160	0.090
80	0.160	0.080

(a) (i) Calculate the percentage loss in the mean mass of the woodlice in Group **A** during the investigation. Show your working.

Answer _____

(2)

(ii) Woodlice in Group **B** had a greater percentage loss in mean mass during the investigation than woodlice in Group **A**. Explain why.

_____

_____

_____

_____

_____

_____

(Extra space)_____

_____

_____

(3)

(iii) It would be useful to give the loss in mean mass as a percentage in this investigation.
Explain why.

_____

_____

(1)

(Total 6 marks)

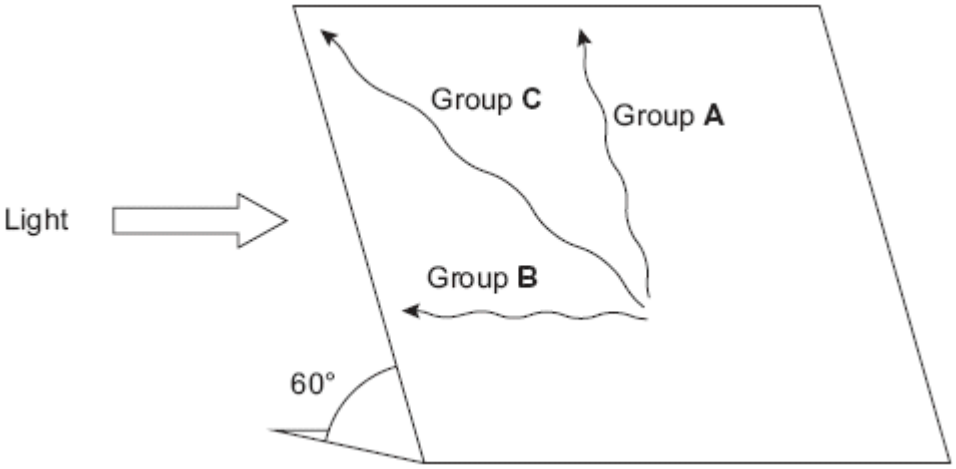
Q15.

Termites are insects. Some species live in colonies in the soil. Although most termites are wingless, winged termites are sometimes produced. The winged termites fly from the soil, mate and start new colonies.

A scientist studied the behaviour of winged termites. He divided these termites into three groups.

- Group **A** had their eyes covered.
- Group **B** had their antennae removed.
- Group **C** was the control group.

He put individual winged termites on a sloping board that was illuminated from one side. The diagram shows the direction of movement of a typical termite from each of the three groups.



(a) (i) What type of behaviour was shown by the termite from group **B**?

_____

(1)

(ii) Give the evidence for your answer.

_____

_____

(1)

(b) Explain what the results from group **A** suggest about the factors controlling the behaviour of winged termites.

_____

_____

_____

_____

_____

_____

(3)

(c) Suggest **one** advantage to the termites from group **C** of the behaviour shown in the investigation.

_____

_____

_____

_____

(2)

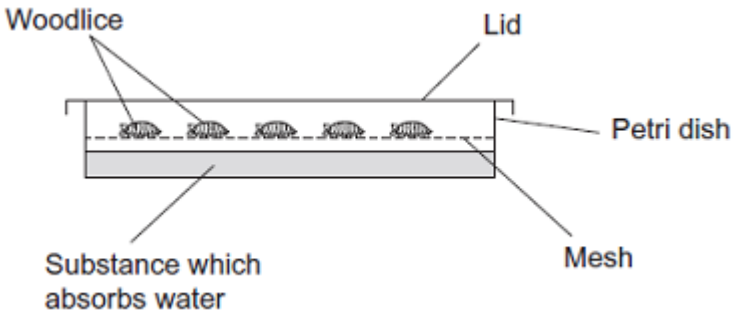
(Total 7 marks)

Q16.

Scientists investigated the effect of relative humidity on the activity of woodlice. They set up a Petri dish as shown in **Figure 1**.

In the bottom half they put a substance which absorbs water. Different concentrations of this substance produced different humidities in the air above the mesh.

Figure 1

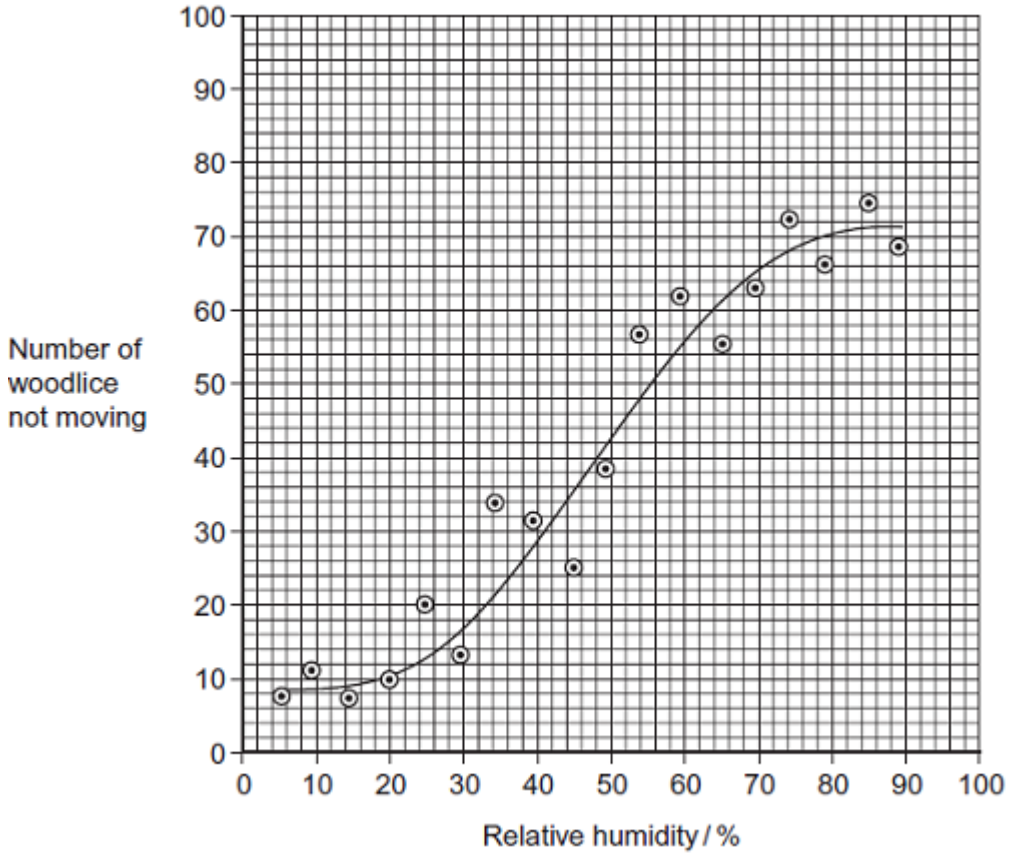


The scientists

- placed 10 woodlice in the top half of the dish
- replaced the lid and left the apparatus for 15 minutes in the laboratory
- recorded the number of woodlice **not** moving during the next 30 seconds
- repeated the experiment to obtain data for 100 woodlice
- repeated the experiment at different humidities.

The results are shown in **Figure 2**.

Figure 2



The movement of the woodlice in low relative humidity is an advantage to their survival. Explain how.

_____

_____

_____

_____

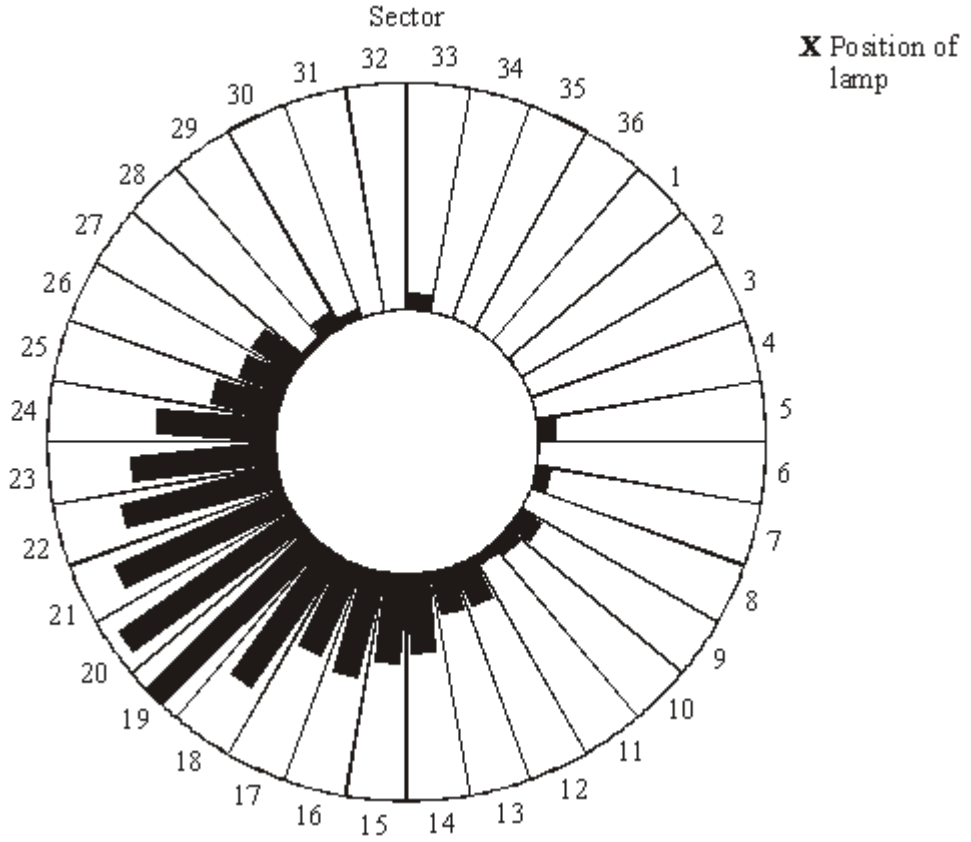
_____

(Total 2 marks)

Q17.

Students investigated the response of beetle larvae to light. They marked sectors on a large circular sheet of cardboard. A lamp with a 100 W bulb was placed close to the cardboard sheet at position **X**. The larvae were released, one at a time, in the centre of the sheet. The direction in which each larva moved was determined by recording the sector into which it first crawled.

The results of 300 trials are shown in the diagram. The length of the bars indicates the number of larvae moving into each sector.



(a) The students concluded that the larvae respond by moving away from light.

(i) What is the evidence for this conclusion?

_____

_____

(1)

(ii) Suggest **one** precaution that would ensure the response really was due to light.

_____

_____

(1)

(iii) The larvae moved to a wide range of different sectors. Suggest an explanation for this.

_____

_____

(1)

(b) The sector which gave the median result was sector 20. Explain how the median result would be calculated.

_____

_____

_____

_____

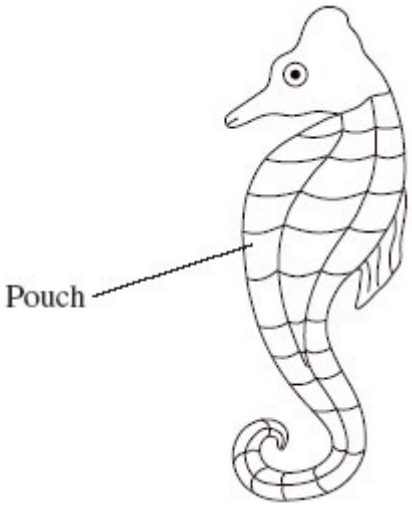
_____

(2)

(Total 5 marks)

Q18.

The diagram shows a seahorse. A seahorse is a fish. Mating in seahorses begins with courtship behaviour. After this, the female transfers her unfertilised eggs to the male's pouch. Most male fish fertilise eggs that have been released into the sea. However, a male seahorse fertilises the eggs while they are inside his pouch. The fertilised eggs stay in the pouch where they develop into young seahorses.



(a) Give **two** ways in which courtship behaviour increases the probability of successful mating.

1. _____

_____

2. _____

_____

(2)

(b) Give **one** way in which reproduction in seahorses increases the probability of

(i) fertilisation

_____

_____

(1)

(ii) survival of young seahorses.

_____

_____

(1)

Scientists investigated the effect of total body length on the selection of a mate in one Australian species of seahorse. The scientists used head length as a measure of total body length.

(c) (i) Use the diagram to suggest why the scientists measured head length rather than total body length.

_____

_____

(1)

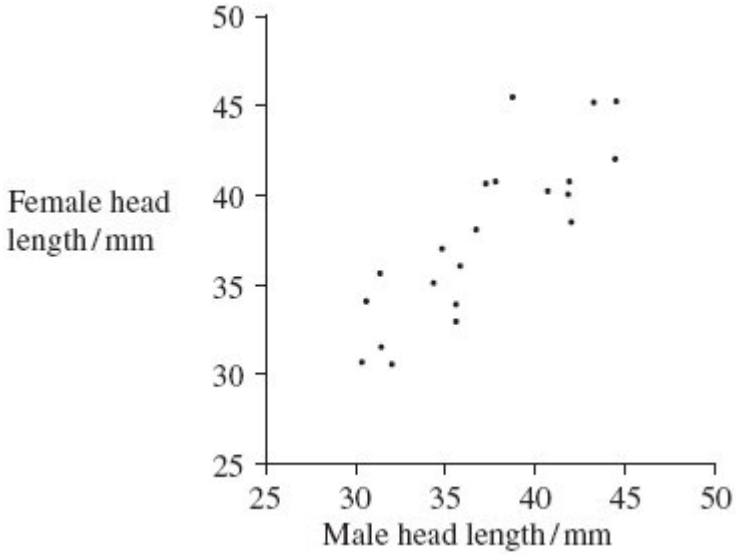
(ii) Suggest why the scientists were able to use head length as a measure of total body length.

_____

_____

(1)

The scientists measured the head lengths of the female and male of a number of pairs. The results are shown in the graph.



(d) The scientists concluded that total body length affects the selection of a mate. Explain how the results support this conclusion.

_____

_____

(1)

(e) A female with a head length of 50 mm selected a mate. Explain how you could use the graph to predict the total head length of the mate selected.

_____

(2)

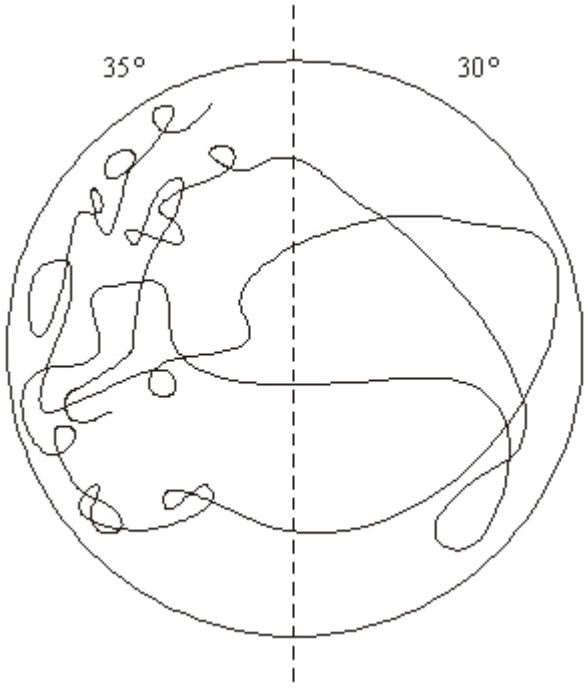
(f) Scientists studied two species of North American seahorse. They thought that these two species are closely related. Describe how comparisons of biological molecules in these two species could be used to find out if they are closely related.

(6)

(Total 15 marks)

Q19.

The human body-louse is an insect which lives and feeds on the surface of the skin. A louse was placed in a chamber, half of which was kept at 35 °C and half at 30 °C. The diagram shows the pattern of movement of the louse.



(a) Name the type of behavioural response shown by the body-louse in this investigation.

Give evidence for your answer.

_____

_____

_____

_____

(2)

(b) Suggest and explain **one** advantage of this behaviour to the human body-louse.

_____

_____

_____

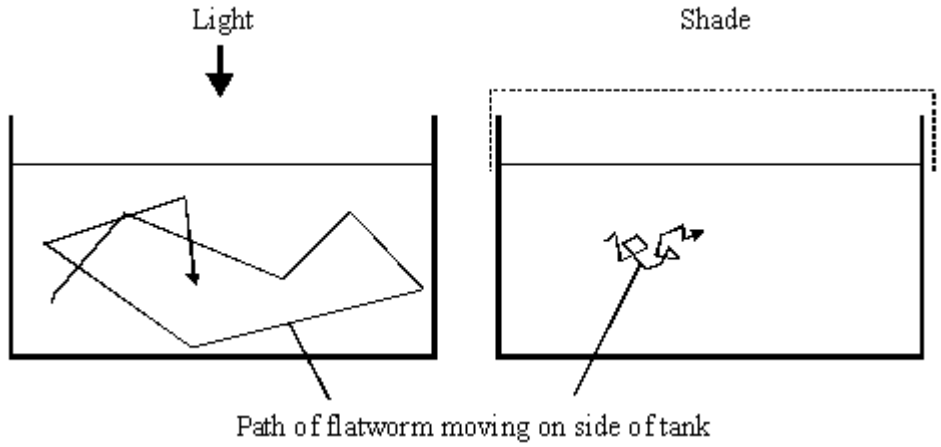
_____

(2)

(Total 4 marks)

Q20.

A flatworm is a simple soft-bodied animal. The diagram shows the movements of an aquatic flatworm in light and in shade. The path followed by the flatworm over a period of three minutes was traced on the side of a tank.



(i) Name the type of behaviour shown. Give a reason for your answer.

Type of behaviour _____

Reason _____

_____

(2)

(ii) Suggest **one** advantage of the behaviour shown in the diagram.

_____

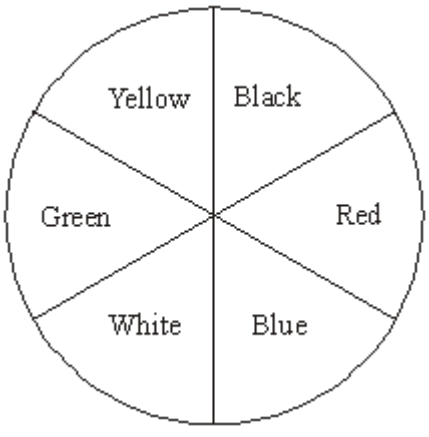
_____

(1)

(Total 3 marks)

Q21.

In an investigation by a student into the responses of maggots, the bottom of a large box was marked with six coloured segments, as shown in the diagram.



30 maggots were placed on each segment in the box. A transparent cover was put on the box and light bulbs were positioned so that the segments were evenly illuminated. The positions of the maggots were recorded after one hour. The intensity of the light reflected by each segment was measured.

The experiment was repeated three more times. The total number of maggots in each segment from the four experiments is shown in the table.

Colour of segment	Intensity of reflected light / arbitrary units	Total number of maggots
Black	4	154
Red	25	229
Blue	10	178
White	44	47
Green	25	48
Yellow	40	64

(a) Give **one** conclusion about the responses of maggots which is supported by these results.

_____

_____

Give the evidence from the table for your conclusion.

_____

_____

(2)

(b) The chi-squared test was used to analyse the data. For the results obtained, suggest **one** null hypothesis which might be analysed by a chi-squared test.

_____

_____

(1)

(c) It was suggested that the movement of the maggots might have been influenced by the Earth's magnetic field. Suggest **one** simple way of repeating the investigation which would avoid this possibility.

_____

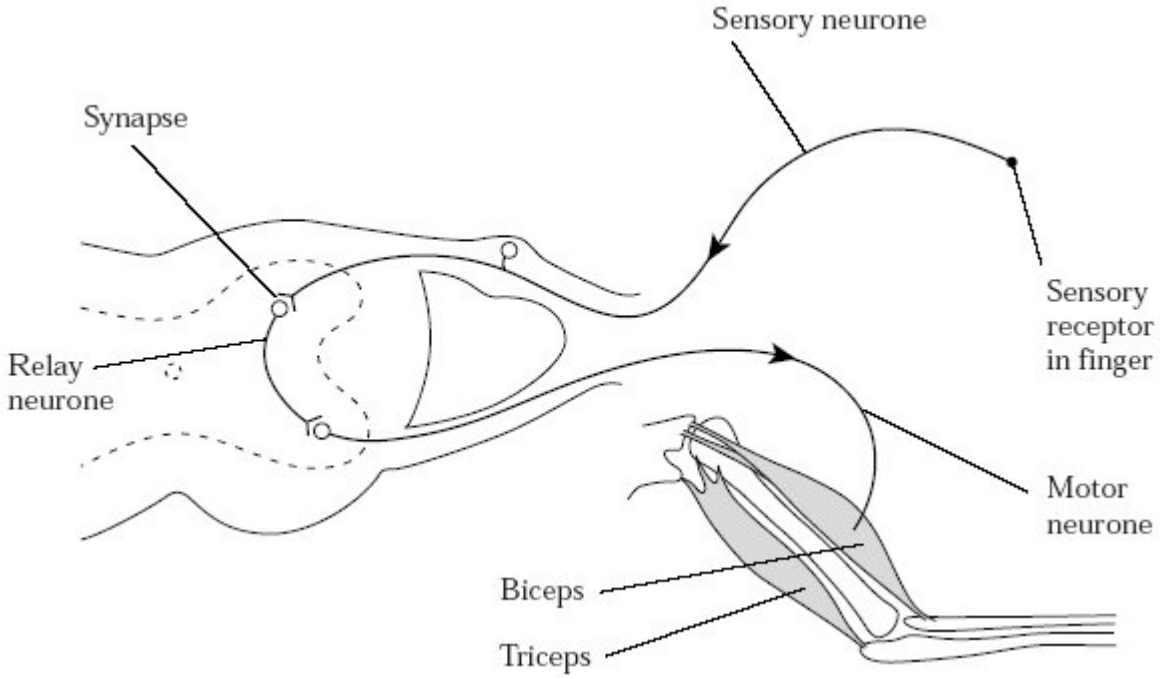
_____

(1)

(Total 4 marks)

Q22.

When a finger accidentally touches a hot object, a reflex action occurs. The biceps muscle contracts, causing the arm to be flexed and the finger is pulled away. The diagram shows the arrangement of the bones in the arm, the muscles used for flexing and straightening the arm and the nervous pathways associated with the contraction of these muscles.



(a) Explain the importance of reflex actions.

(3)

(b) (i) Describe the sequence of events which allows information to pass from one neurone to the next neurone across a cholinergic synapse.

_____

_____

_____

(6)

(ii) Give **two** differences between a cholinergic synapse and a neuromuscular junction.

1. _____

_____

2. _____

_____

(2)

(Total 11 marks)