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Question 1

- (a) An American doctor, Dr William Bean, studied the growth of his fingernails for 35 years. He filed a horizontal line on his thumbnail just above the cuticle (the strip of skin at the base of the nail). By recording how long it took the mark to reach the tip of the thumbnail he was able to calculate the growth rate. He was eventually able to conclude:

A 35-year observation of the growth of my nails indicates the slowing of growth with increasing age. The average daily growth of the left thumbnail, for instance, has varied from 0.123 mm a day during the first part of the study when I was 32 years of age to 0.095 mm a day at the age of 67.

- (i) Identify the independent variable (IV) and the dependent variable (DV) in this study. (2 marks)

IV:

DV:

- (ii) Is this a controlled experiment? Explain. (2 marks)

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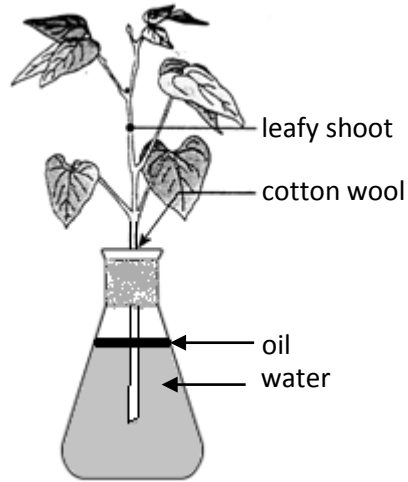
- (b) A scientist counted the number of chirps that crickets made in 10 seconds at three different altitudes. He found that at sea level the crickets chirped 46 times in 10 seconds; at 250 metres above sea level they chirped 32 times in 10 seconds, and at 500 metres above sea level the crickets chirped 19 times in 10 seconds.

Suggest a hypothesis to account for the scientist's findings. (3 marks)

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Question 2

A student put a leafy shoot from a laurel plant into a potometer, as shown in the diagram below. The student put a second leafy shoot into another potometer.



- (a) Explain how this potometer could be used to measure transpiration. Include in your answer the significance of the oil layer. (3 marks)

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Question 2 continues.

Question 2 (continued)

The student smeared the leaves of each shoot with petroleum jelly, which is a waterproofing agent. First one surface, then the other. A different sequence of treatments was used for each shoot, as described in the tables below.

Shoot 1		
Treatment	Surface covered with petroleum jelly	Amount of Transpiration (arbitrary units)
1 st	Neither	83
2 nd	Upper	65
3 rd	Upper and lower	4

Shoot 2		
Treatment	Surface covered with petroleum jelly	Amount of Transpiration (arbitrary units)
1 st	Neither	95
2 nd	Lower	18
3 rd	Upper and lower	5

The leaves of the laurel plant only have stomata in the lower epidermis; there are no stomata in the upper epidermis.

(b) What evidence in the tables shows that transpiration occurs:

(i) mainly through the stomata of the leaves? (2 marks)

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(ii) partly through the cuticle of the leaves? (2 marks)

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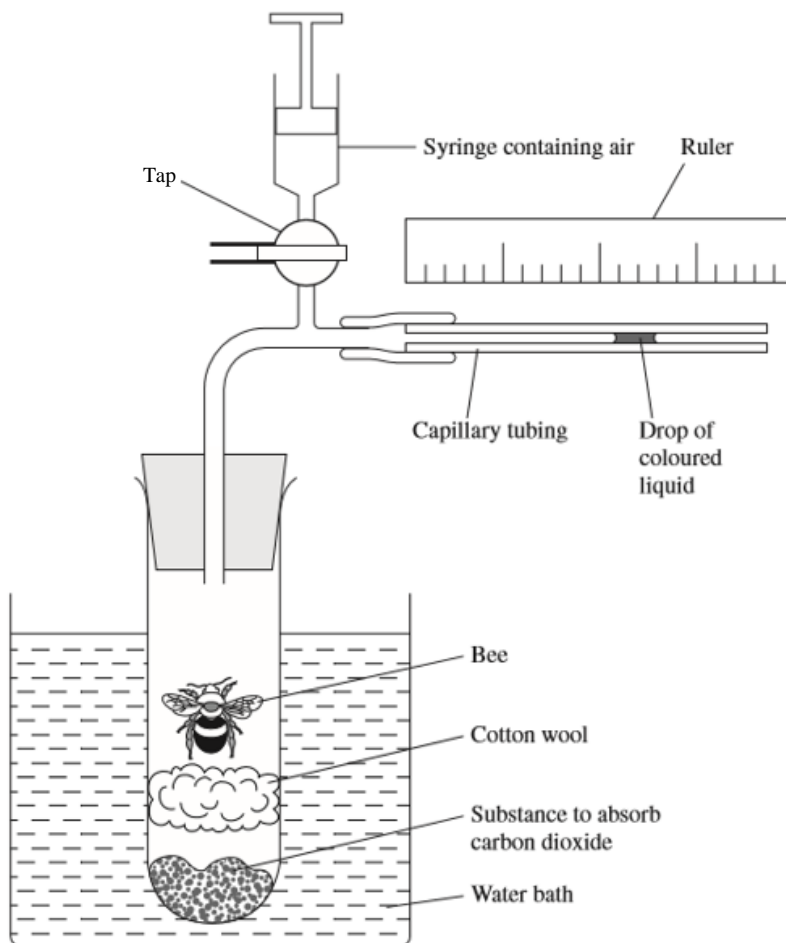
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Question 3

A respirometer, like the one shown below, can be used to measure the rate of oxygen consumption of individual bees. A tube containing a bee is placed in the water bath until it reaches the required temperature. The tap is then closed and the drop of coloured liquid starts to move steadily along the capillary tube.



(a) In which direction would the liquid move? Explain your answer. (2 marks)

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(b) What is the syringe containing air used for? (1 mark)

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Question 3 continues.

(c) What measurements would you need to make using this apparatus in order to obtain data on the **rate** of oxygen consumption of a bee? (1 mark)

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(d) Adam carried out an investigation into the effect of different environmental temperatures on oxygen consumption in the honey bee, *Apis mellifera*. Rather than using a single bee in each trial, he used a larger respirometer that could comfortably hold 10 bees. At each temperature he measured the rate of oxygen consumption of the bees. He did this three times for each temperature he used and then calculated the average oxygen consumption for that temperature. He used a different group of 10 bees for each temperature.

(i) Adam believed that using a group of 10 bees improved his experiment. Explain how. (2 marks)

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(ii) Thousands of bees were available in a hive. How should Adam select specimens for his experiment? Justify your answer. (2 marks)

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The table below shows the data that Adam obtained.

Temperature (°C)	Rate of Oxygen Consumption (arbitrary units)			
	Trial 1	Trial 2	Trial 3	Average
10	2.1	2.3	2.1	2.2
15	3.8	3.6	3.9	3.8
20	7.5	7.3	7.8	7.5
25	11.2	11.1	7.3	10.0
30	15.3	15.6	14.9	15.3
35	22.5	18.3	18.1	19.6
40	30.3	28.6	30.8	29.9

(e) Identify **one** anomalous (unexpected) result in Adam's table and explain why you selected it. (2 marks)

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(f) Adam was confident that he had measured the rate of oxygen consumption correctly in each trial. Identify one experimental error that could have caused this unexpected result. Explain. (2 marks)

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(g) It was suggested that the temperature range should be extended to 55°C. What do you predict would happen to the bees' oxygen consumption at these temperatures and would this make a good follow-up experiment? Explain with reasons. (3 marks)

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Question 4

Twin studies are often undertaken for the purposes of medical research. The Older Australian Twins Study (OATS) was set up in 2007 to investigate genetic and environmental factors and their impact on healthy brain ageing and brain disease. Participants were invited from all states in Australia and their contribution was voluntary.

The study had a number of features including comprehensive psychiatric, cardiovascular, metabolic and neuroimaging assessments conducted by a combination of medical tests and participant survey. The study also measured many behavioural and environmental factors including lifetime physical and mental activity, alcohol and drug use, occupational risk factors and nutrition.

The initial sample size was 623 individuals, comprising over 250 pairs of twins (both identical and non-identical twins are included) and, where possible, another sibling. Participants were aged 65–90 years and were assessed every 2 years, with the same in-depth tests and surveys repeated at this time. Participants provided written consent and OATS was approved by various ethics committees, including the Australian Twin Registry, University of Melbourne and Queensland Institute of Medical Research.

Use the above information to highlight and explain the strengths and any weaknesses of the design of this study. (6 marks)

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