

**Paper Reference(s) 9BI0/02**

**Pearson Edexcel Level 3 GCE**

**Biology B**

**Advanced**

**Paper 2: Advanced Physiology, Evolution  
and Ecology**

**Thursday 13 June 2019 – Morning**

**Time: 1 hour 45 minutes plus your additional  
time allowance**

**INSTRUCTIONS TO CANDIDATES**

**Write your centre number, candidate number,  
surname, other names and your signature in  
the boxes below. Check that you have the  
correct question paper.**

<b>Centre No.</b>					
<b>Candidate No.</b>					
<b>Surname</b>					
<b>Other names</b>					
<b>Signature</b>					
<b>Paper Reference</b>	<b>9</b>	<b>B</b>	<b>I</b>	<b>0</b>	<b>/ 0 2</b>



- **Use BLACK ink or ball-point pen.**
- **Answer ALL questions.**
- **Show your working in any calculation questions and include units in your answer where appropriate.**
- **Answer the questions in the spaces provided – there may be more space than you need.**
- **You may use a scientific calculator.**

**MATERIALS REQUIRED FOR EXAMINATION**  
**Calculator, HB pencil, ruler**

**ITEMS INCLUDED WITH QUESTION PAPERS**  
**Nil**

**(Instructions continue on next page)**

**(Turn over)**

## **INFORMATION FOR CANDIDATES**

- The total mark for this paper is 90.
- The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.
- In question(s) marked with an **ASTERISK (\*)**, marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

## **ADVICE TO CANDIDATES**

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

**(Turn over)**

**Answer ALL questions.**

**Write your answers in the spaces provided.**

**Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.**

**(Questions begin on next page)**

**(Turn over)**

- 1 The photographs show a black cat and a Siamese cat.**



**© Tim Macpherson,  
Cultura/Science photo library**



**© BSIP Laurent/Gluck/Science photo library**

**(Question continues on next page)**

**(Turn over)**

The pigment melanin causes the fur to turn black.

This pigment is produced by tyrosinase, an enzyme coded by the TYR gene.



(a) (i) The diagram shows part of the DNA for the TYR gene.

A	C	C	C	C	A	A	G	G	C	T	C
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Complete the diagram to show the messenger RNA produced by the transcription of this DNA.  
(1 mark)

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(Question continues on next page)

(Turn over)

- (ii) Some amino acids have more than one codon.

Which term describes this property of the genetic code?  
(1 mark)

- ☐ A degenerate
- ☐ B non-overlapping
- ☐ C triplet code
- ☐ D universal

(Question continues on next page)

(Turn over)

**(b) Siamese cats have a mutation in their TYR gene.**

**This changes the secondary and tertiary structures of tyrosinase.**

**(i) Which of the following shows the type of bonding involved in both the secondary and tertiary structures of a protein? (1 mark)**

- ☐ **A hydrogen only**
- ☐ **B hydrogen and ionic**
- ☐ **C ionic and disulfide**
- ☐ **D ionic only**

**(Question continues on next page)**

**(Turn over)**



- (ii) Explain why the cooler regions of a Siamese cat have dark coloured fur and the warmer regions have lighter coloured fur. (3 marks)**

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**(Continue your answer on next page)**

**(Turn over)**

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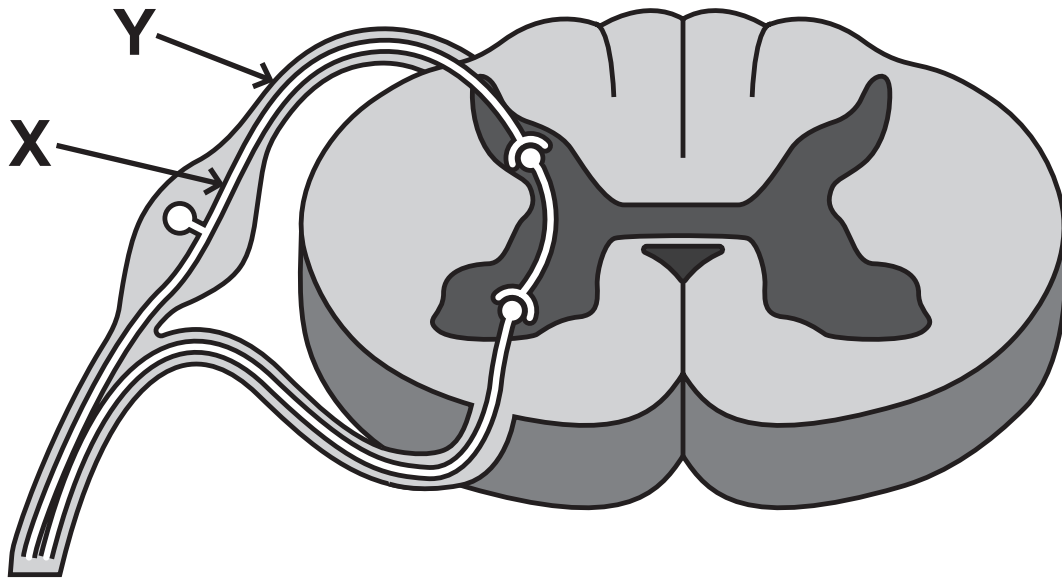
**(TOTAL FOR QUESTION 1 = 6 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

- 2 (a) (i) The diagram shows a section through the spinal cord.



(Question continues on next page)

**Which row correctly names the structures labelled X and Y?  
(1 mark)**

	<b>X</b>	<b>Y</b>
<input type="checkbox"/> <b>A</b>	<b>motor neurone</b>	<b>dorsal root</b>
<input type="checkbox"/> <b>B</b>	<b>motor neurone</b>	<b>ventral root</b>
<input type="checkbox"/> <b>C</b>	<b>sensory neurone</b>	<b>dorsal root</b>
<input type="checkbox"/> <b>D</b>	<b>sensory neurone</b>	<b>ventral root</b>

**(Question continues on next page)**

**(Turn over)**

**(ii) Which region of the brain only controls breathing and heart rate? (1 mark)**

- ☐ **A cerebellum**
- ☐ **B cerebrum**
- ☐ **C hypothalamus**
- ☐ **D medulla oblongata**

**(b) Explain how the resting potential is maintained in a neurone. (4 marks)**

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**(Continue your answer on next page)**

**(Turn over)**

**(Turn over)**

**(c) The photograph shows a blue-ringed octopus.**



**This octopus produces tetrodotoxin that it uses to paralyse its prey.**

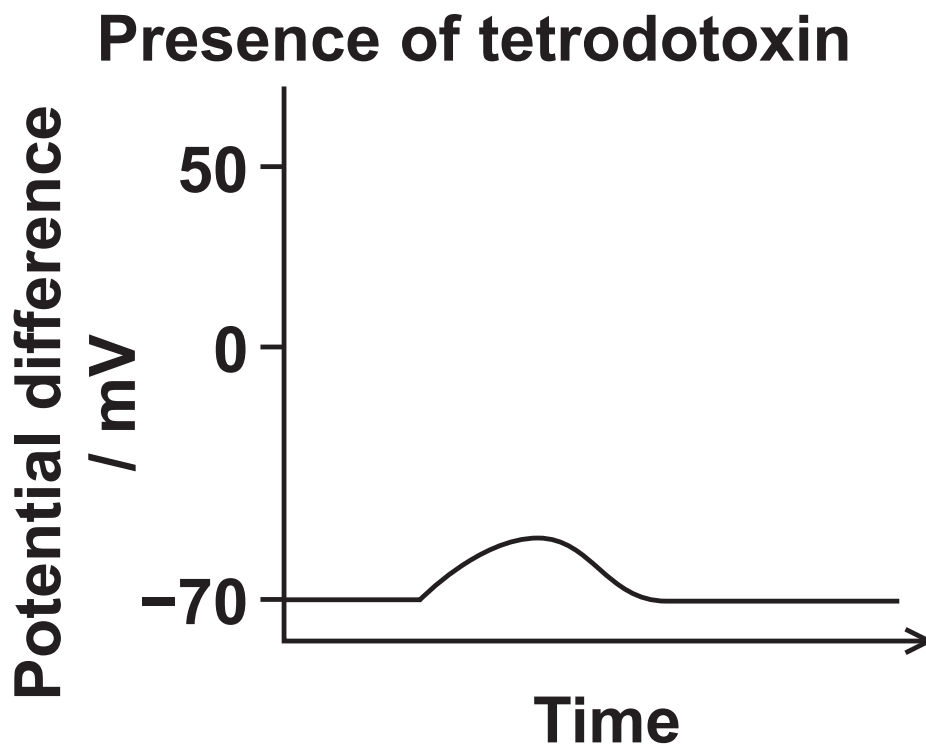
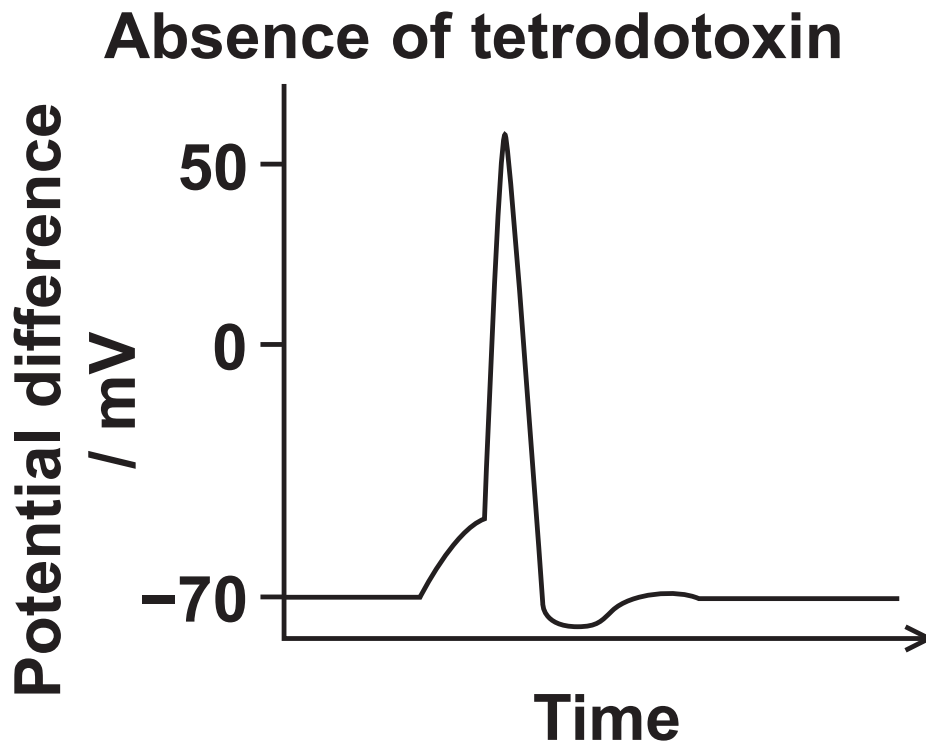
**The effects of tetrodotoxin on a neurone were investigated.**

**A neurone was stimulated in the absence of and in the presence of tetrodotoxin.**

**(Question continues on next page)**

**(Turn over)**

The graphs show the results of this investigation.



(Question continues on next page)

(Turn over)



**Comment on how tetrodotoxin affects the potential difference of a neurone when the prey of the octopus is paralysed. (4 marks)**

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**(Continue your answer on next page)**

**(Turn over)**

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**(TOTAL FOR QUESTION 2 = 10 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

**3 In 2014 there was an Ebola virus outbreak in West Africa.**

**(a) Which of the following viruses contains RNA and the enzyme reverse transcriptase? (1 mark)**

- ☐ **A Ebola virus**
- ☐ **B human immunodeficiency virus (HIV)**
- ☐ **C  $\lambda$  (lambda) phage**
- ☐ **D tobacco mosaic virus**

**(Question continues on next page)**

**(Turn over)**

**(b) Ebola virus begins its lytic cycle soon after the infection of body cells.**

**(i) Describe the lytic cycle of a virus.  
(2 marks)**

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**(Question continues on next page)**

**(Turn over)**

- (ii) Some doctors believe that the Ebola virus may undergo latency within body cells.

State what is meant by the term latency. (2 marks)

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(Question continues on next page)

(Turn over)

- (c) An experimental drug called Zmapp was used to treat patients during this outbreak of Ebola virus.**

**Patients with Ebola virus were randomly split into two groups.**

**Both groups received standard medical treatment.**

**One group was also given Zmapp on days 1, 3 and 5.**

**Some of the patients suffered severe side effects after treatment with Zmapp and required additional medical care.**

**(Question continues on next page)**

**(Turn over)**

The results are shown in the table.

Day	Number of patients surviving		Number of patients with severe side effects after treatment with Zmapp on days 1, 3 and 5
	Without Zmapp	With Zmapp	
1	35	36	11
2	32	33	
3	31	31	7
4	30	29	
5	29	28	3
6	26	28	
7	23	28	
8	22	28	
9	22	28	

(Question continues on next page)

(Turn over)

**Analyse the data to assess the effectiveness of Zmapp to treat patients with Ebola virus. (4 marks)**

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**(Continue your answer on next page)**

**(Turn over)**



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**(TOTAL FOR QUESTION 3 = 9 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

- 4 The photograph shows a maize cob with smooth, wrinkled and different coloured grains.**



**© W.P. Armstrong 2001**

**The shape and colour of maize grains are controlled by two unlinked genes.**

**The allele for smooth seeds (A) is dominant to the allele for wrinkled seeds (a).**

**The allele for purple seeds (B) is dominant to the allele for yellow seeds (b).**

**(Question continues on next page)**

**(Turn over)**

**(a) State all the possible genotypes of a smooth, purple grain. (1 mark)**

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**(Question continues on next page)**

**(b) Two maize plants, grown from grains that were both wrinkled and purple, were cross-pollinated.**

**In the  $F_1$  generation, some grains were wrinkled and purple and some were wrinkled and yellow.**

**Which of the following shows the genotypes of the parent plants?  
(1 mark)**

☐ **A    $AaBb \times AaBb$**

☐ **B    $aaBB \times aaBB$**

☐ **C    $AABb \times AABB$**

☐ **D    $aaBb \times aaBb$**

**(Question continues on next page)**

**(Turn over)**

- (c) A student cross-pollinated a maize plant grown from a smooth, purple grain (heterozygous for both pairs of alleles) with a maize plant grown from a wrinkled, yellow grain.**

**(Question continues on next page)**

**Using a genetic diagram, determine the probability that this cross will produce grains that are wrinkled and purple. (4 marks)**

**Answer \_\_\_\_\_**

**(TOTAL FOR QUESTION 4 = 6 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

**5 Chemical control in plants involves plant growth substances.**

**(a) Which of the following effects are caused by auxin? (1 mark)**

**1 cell elongation**

**2 suppression of lateral bud growth**

**3 photomorphogenesis**

☐ **A 1 and 2**

☐ **B 1 and 3**

☐ **C 2 and 3**

☐ **D 1, 2 and 3**

**(Question continues on next page)**

**(Turn over)**

**\*(b) The effect of day length on flowering in two species of plants, Kalanchoe and Sedum, was investigated.**

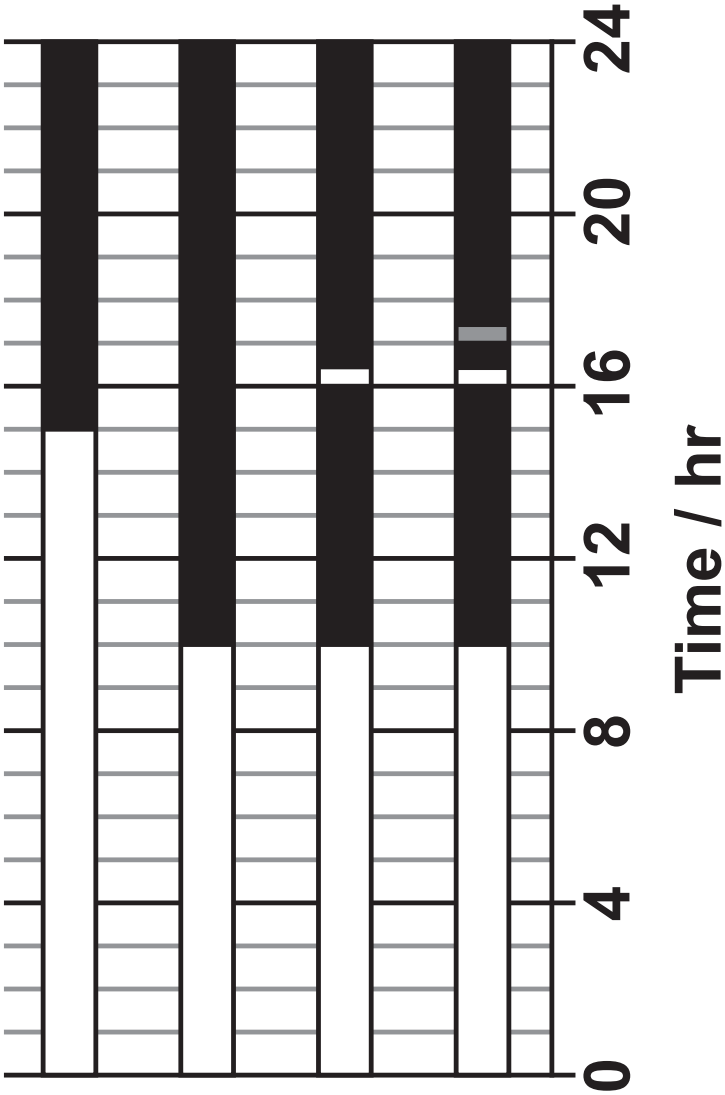
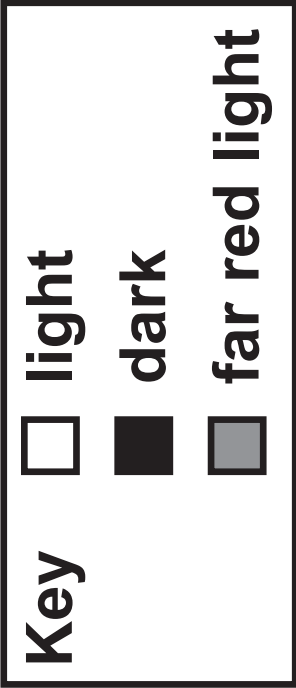
**The effect of different periods of light and darkness and the effects of exposure to far red light were investigated.**

**The diagram on page 33 shows the results of this investigation.**

**(Question continues on next page)**

**(Turn over)**



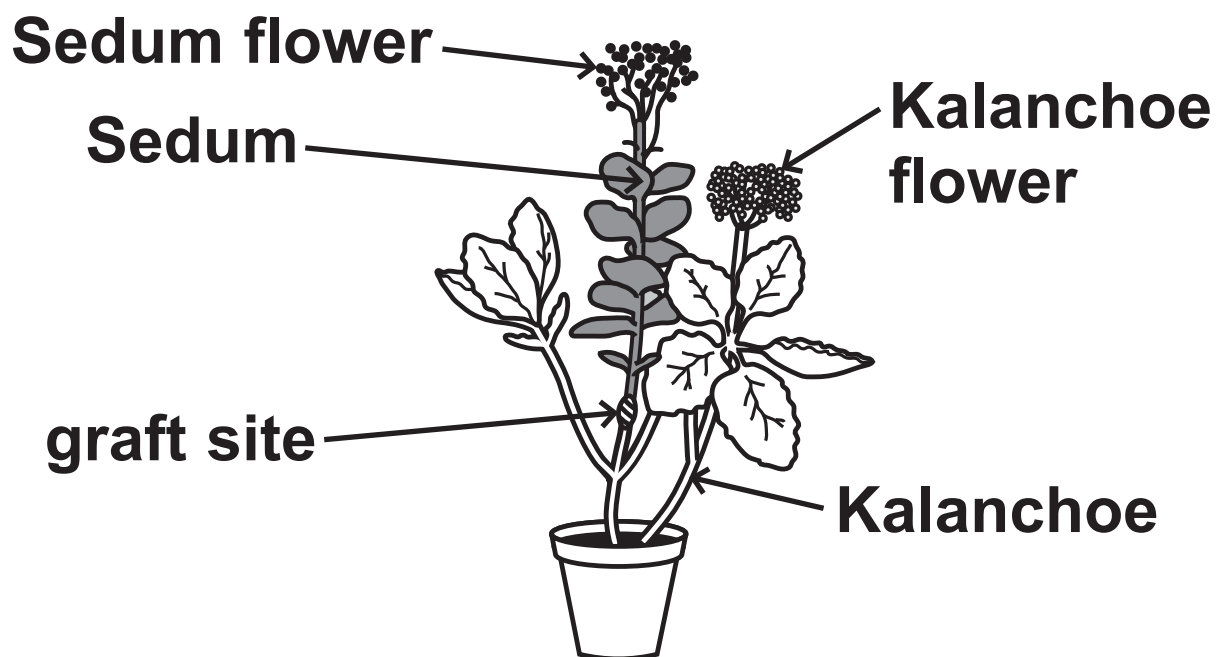


Kalanchoe	Sedum
no flowers	flowers
flowers	no flowers
no flowers	flowers
flowers	no flowers

**In another investigation, a piece of Sedum was grafted onto the stem of a Kalanchoe plant.**

**This plant and graft were exposed to 10 hours of light followed by 14 hours of darkness.**

**The Kalanchoe and the Sedum graft both produced flowers, as shown in the diagram.**



**(Question continues on next page)**

**(Turn over)**

**Analyse the data to explain the effects of different light periods and far red light on flowering in Kalanchoe and Sedum. (6 marks)**

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**(Continue your answer on next page)**  
**(Turn over)**

**(Continue your answer on next page)**  
**(Turn over)**

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**(TOTAL FOR QUESTION 5 = 7 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

- 6 The photograph shows a brown tree snake.**



**© staticflickr.com**

**The brown tree snake is found in areas of Indonesia.**

**This snake eats small mammals, birds and reptiles.**

**In the 1940s, the brown tree snake was introduced to the Pacific Island of Guam.**

**The population of this snake is now over two million.**

**Its introduction has had major effects on bird species in Guam.**

**(Question continues on next page)**

**(Turn over)**

The table shows the numbers of individuals of each bird species surveyed in the areas where this snake was present.

Species	1981	1982	1983	1984	1985	1986
Island collared-dove	0	0	3	19	1	0
White-throated ground-dove	1	3	5	5	0	0
Marian fruit-dove	11	19	3	0	0	0
Micronesian kingfisher	29	17	35	26	4	0
Marian crow	28	33	47	36	51	0

(Continues on next page)

(Turn over)

<b>Guam flycatcher</b>	<b>6</b>	<b>23</b>	<b>11</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Rufous fantail</b>	<b>74</b>	<b>55</b>	<b>43</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Micronesian starling</b>	<b>148</b>	<b>159</b>	<b>135</b>	<b>71</b>	<b>7</b>	<b>0</b>
<b>Micronesian honeyeater</b>	<b>31</b>	<b>31</b>	<b>33</b>	<b>2</b>	<b>0</b>	<b>0</b>
<b>Bridled white-eye</b>	<b>108</b>	<b>98</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Index of diversity (D)</b>	<b>4·6</b>	<b>4·7</b>	<b>4·1</b>	<b>3·5</b>		<b>0·0</b>

(Question continues on next page)

(Turn over)



- (a) (i) Calculate the index of diversity for 1985 using the formula**

$$D = \frac{N(N - 1)}{\sum n(n - 1)}$$

**(3 marks)**

**Answer** \_\_\_\_\_

**(Question continues on next page)**

**(Turn over)**

- (ii) Explain why using an index of diversity is a better measure of biodiversity than counting the number of species only. (2 marks)**

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**(Question continues on next page)**

**(Turn over)**

**(iii) Comment on the effects of introducing the brown tree snake to Guam. (4 marks)**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

**(Question continues on next page)**

**(Turn over)**

**(b) The biodiversity of plant species on Guam has decreased.**

**(i) Give two reasons why changes in the number of bird species have led to this decrease in biodiversity of plant species.  
(2 marks)**

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**(Question continues on next page)**

**(Turn over)**

- (ii) **Scientists are using seed banks to conserve the biodiversity of plants.**

**Describe how seed banks are used as a method of conservation. (4 marks)**

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**(Continue your answer on next page)**

**(Turn over)**

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**(TOTAL FOR QUESTION 6 = 15 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

**7 Adrenaline is a hormone that stimulates the breakdown of glycogen into glucose.**

**(a) (i) Which of the following describes this breakdown? (1 mark)**

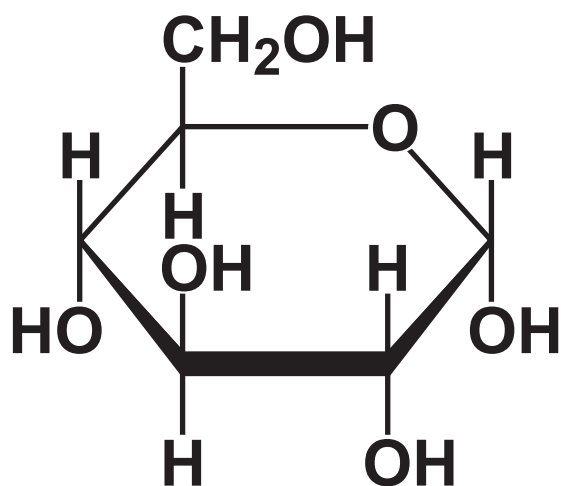
- ☐ **A condensation reaction  
breaking glycosidic bonds**
- ☐ **B condensation reaction  
breaking phosphodiester  
bonds**
- ☐ **C hydrolysis reaction breaking  
glycosidic bonds**
- ☐ **D hydrolysis reaction breaking  
phosphodiester bonds**

**(Question continues on next page)**

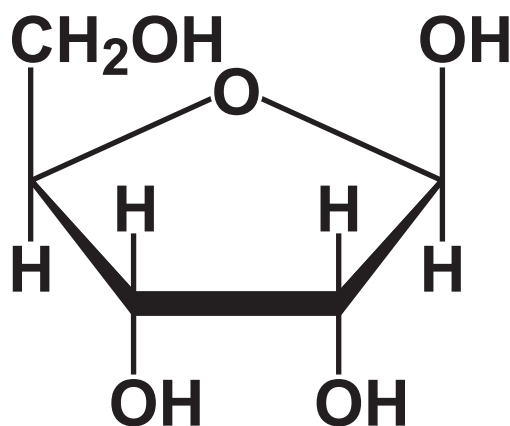
**(Turn over)**

(ii) Which diagram shows the structure of the glucose produced? (1 mark)

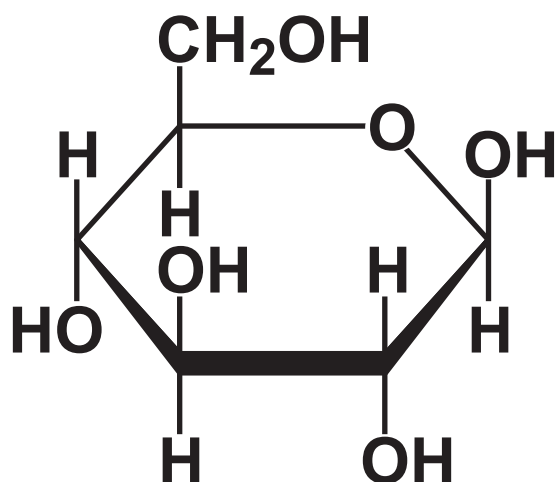
☐ A



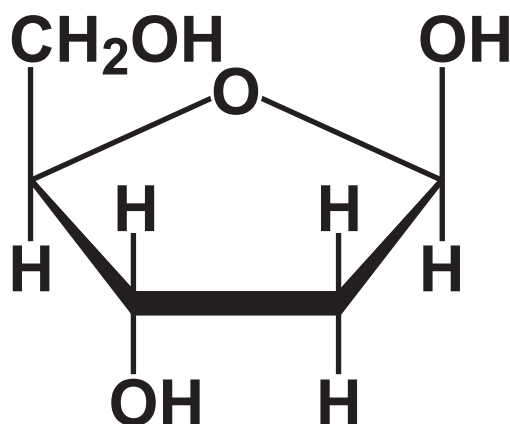
☐ C



☐ B



☐ D



(Question continues on next page)

(Turn over)



**(iii) Explain how the structure of glycogen is related to its function. (3 marks)**

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**(Question continues on next page)**

**(Turn over)**

**(b) The hormone adrenaline is unable to pass through cell membranes.**

**When liver and muscle cells are exposed to adrenaline, the enzyme glycogen phosphorylase breaks down glycogen in these cells.**

**Describe how adrenaline causes liver cells to increase the concentration of glucose in the blood. (3 marks)**

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**(Continue your answer on next page)**

**(Turn over)**

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**(Question continues on next page)**

**(Turn over)**

- (c) The genetic condition Hers disease is caused by a recessive allele of the glycogen phosphorylase gene.**

**In an isolated population of 1400 people in the USA, 15 people have Hers disease.**

**(Question continues on next page)**

- (i) Calculate the number of heterozygous individuals in this population. (4 marks)

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

Answer\_\_\_\_\_

(Question continues on next page)

(Turn over)

- (ii) The frequency of Hers disease in most human populations is 1 in 40 000.

**Explain why the frequency of Hers disease is higher in the isolated population. (2 marks)**

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**(TOTAL FOR QUESTION 7 = 14 MARKS)**

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**(Questions continue on next page)**

**(Turn over)**

- 8 The island of Surtsey was formed by a volcanic eruption in the Atlantic Ocean in 1965.

The photographs show the formation of Surtsey in 1965 and part of the island in 2018.



[volcanocafe.files.wordpress.com](http://volcanocafe.files.wordpress.com)



[vulkaner.no](http://vulkaner.no)

(Question continues on next page)

(Turn over)

**Scientists have been studying the development of ecosystems on this island since its formation.**

**(a) (i) State what is meant by the term ecosystem. (1 mark)**

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**(Question continues on next page)**

**(Turn over)**



- (ii) Explain how ecosystems have developed on Surtsey since 1965.  
(5 marks)**

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**(Question continues on next page)**

**(Turn over)**

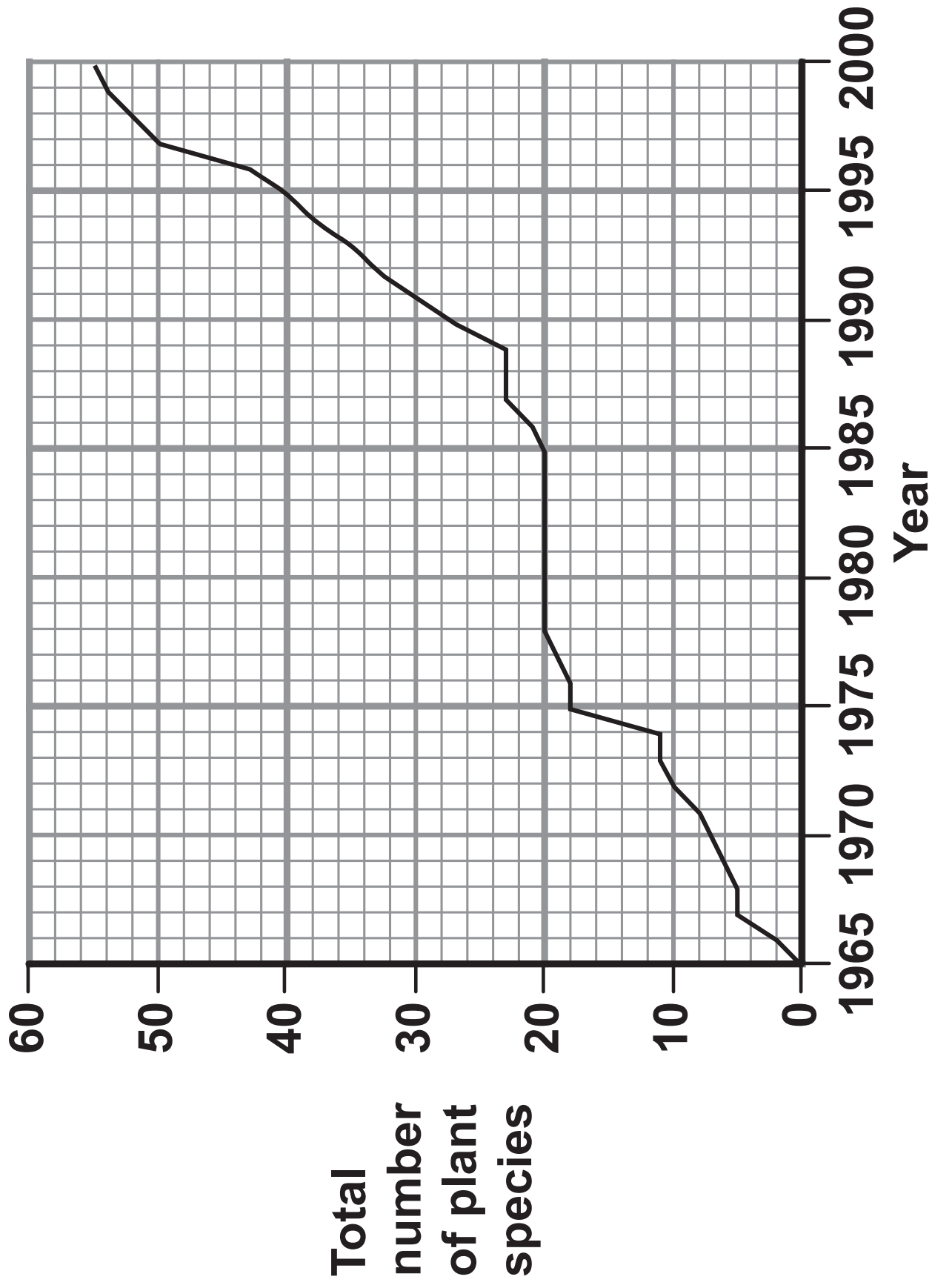
- (b) The scientists recorded the number of different plant species on the island each year from 1965 to 2000.**

**The number of new plant species present at each survey was recorded.**

**The graph on page 60 shows the total number of plant species that have been found on the island.**

**(Question continues on next page)**

**(Turn over)**



vulkaner.no

(Question continues on next page)

(Turn over)

**A few groups of one species of seagull arrived on the island in 1974.**

**In 1985 a large group of a different species of seagull, the black-backed gull, arrived on the island.**

**Comment on the effects of these two species of seagull on the number of plant species. (4 marks)**

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**(Turn over)**

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**(TOTAL FOR QUESTION 8 = 10 MARKS)**

**(Questions continue on next page)**

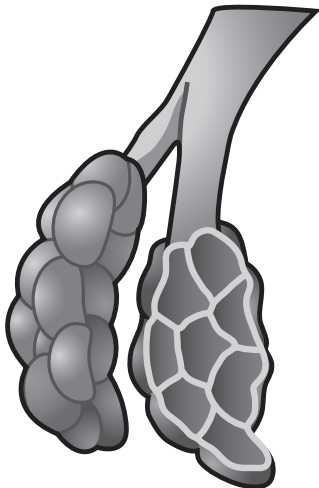
**(Turn over)**

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

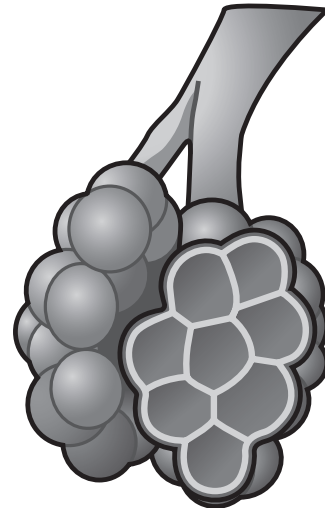
**In ARDS, cells in the alveoli do not produce enough of a substance called surfactant.**

**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**

**(Question continues on next page)**

**(Turn over)**

**(a) 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 mark)**

- ☐ **A covalent**
- ☐ **B ionic**
- ☐ **C hydrogen**
- ☐ **D hydrophobic**

**(Question continues on next page)**

**(Turn over)**



- (ii) Surfactant contains phospholipid molecules.**

**How many of the following components are found in phospholipids? (1 mark)**

- 1     amino acids**
- 2     fatty acids**
- 3     glycerol**
- 4     phosphate**

- ☐ **A     one**
- ☐ **B     two**
- ☐ **C     three**
- ☐ **D     four**

**(Question continues on next page)**

**(Turn over)**

- (b) 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

(Question continues on next page)

(Turn over)

- (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 mark)

Answer \_\_\_\_\_ kPa

(Question continues on next page)

(Turn over)

- (ii) Explain why the Carrico index for the baby with ARDS is lower than the Carrico index for the unaffected baby. (4 marks)

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(Continue your answer on next page)

(Turn over)

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**(Question continues on next page)**

**(Turn over)**

**\*(c) 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.**

**(Question continues on next page)**

**(Turn over)**

**Graph 1 on page 72 and Graph 2 on page 73 show the results of this investigation.**

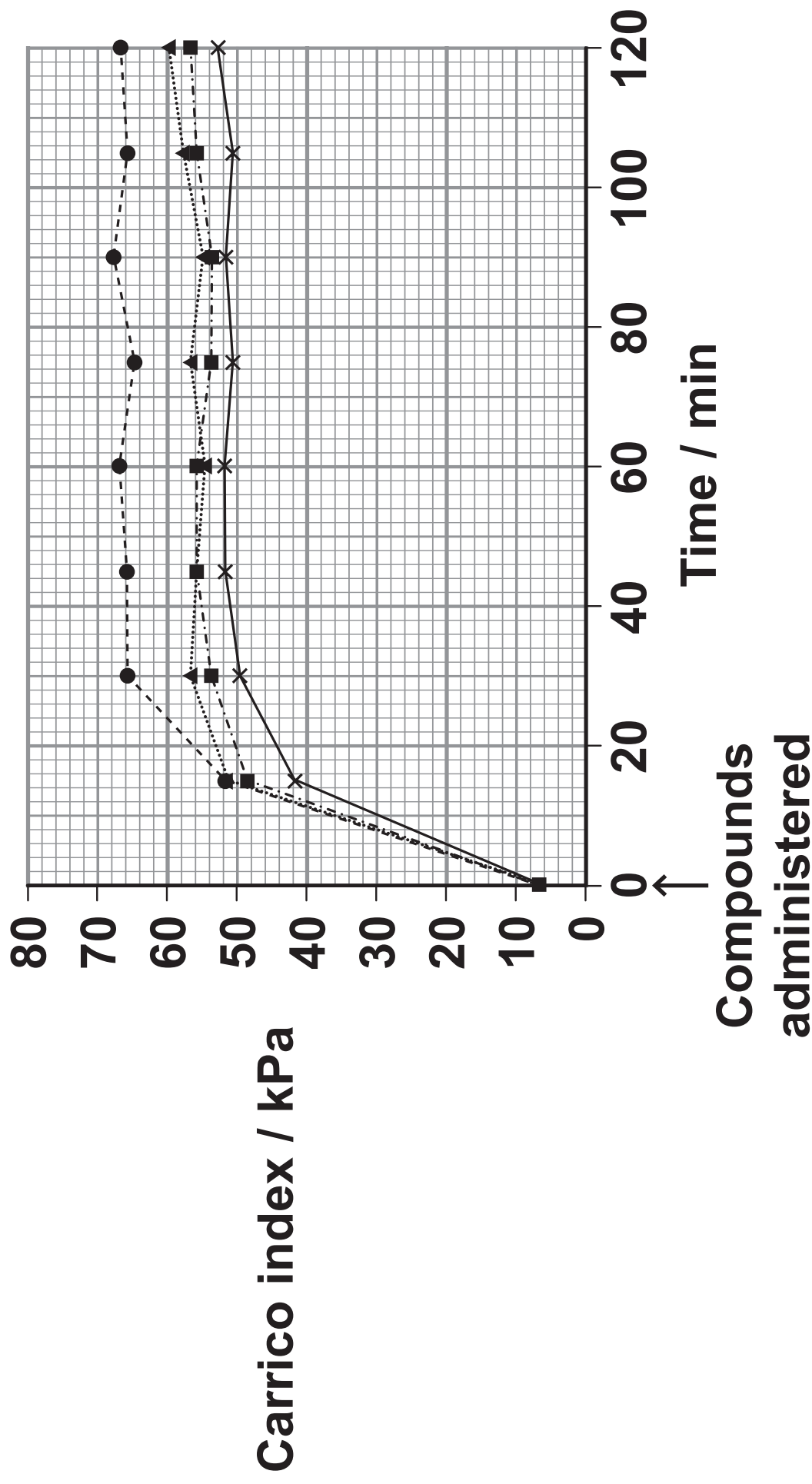
**Key for Graph 1 and Graph 2**

- ×— compound A**
- .....▲..... compound B**
- compounds A and B**
- natural surfactant (control)**

**(Question continues on next page)**

**(Turn over)**

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

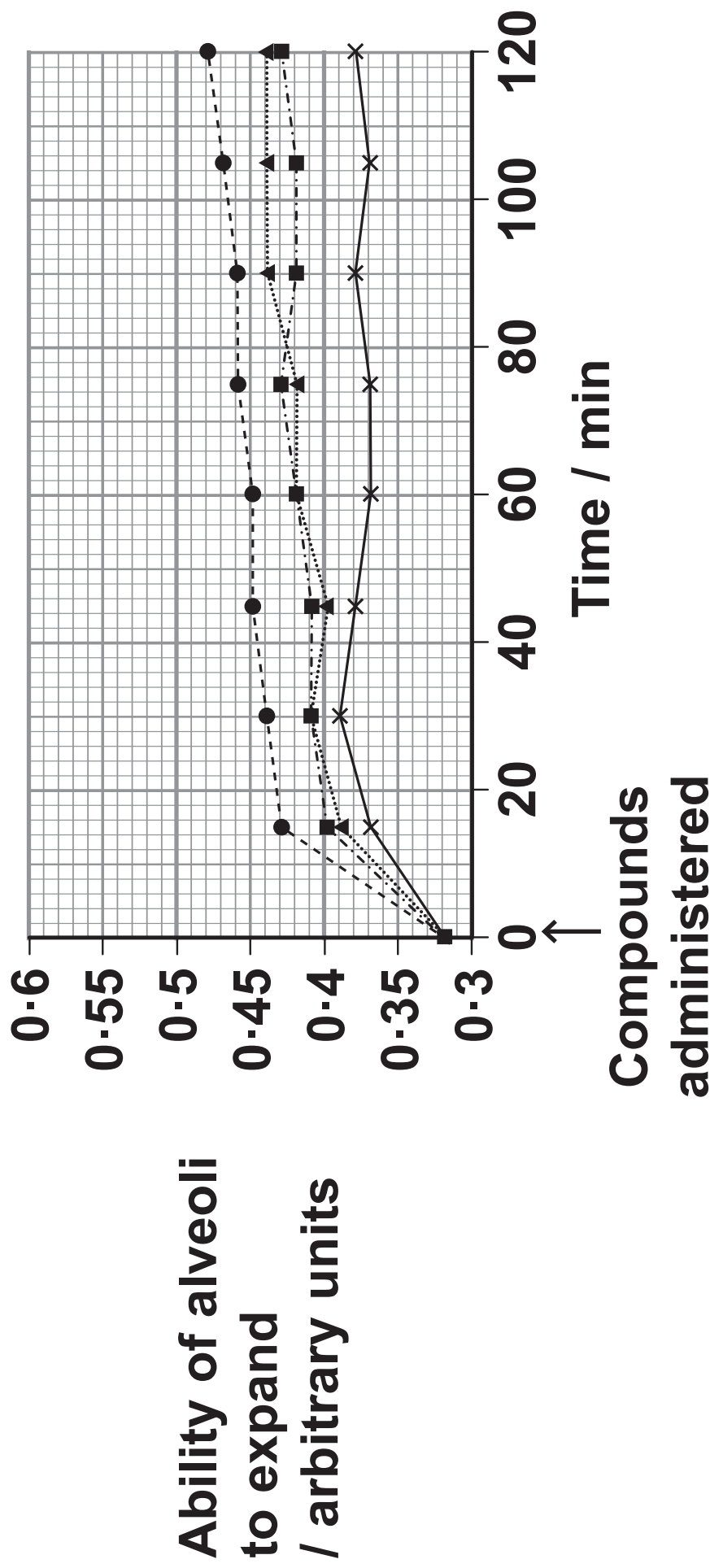


**(Question continues on next page)**

**(Turn over)**



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



**(Question continues on next page)**

**(Turn over)**

**Analyse the data to explain the potential use of these two compounds to treat ARDS in human babies. (6 marks)**

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**(Continue your answer on next page)**  
**(Turn over)**

**(Continue your answer on next page)**  
**(Turn over)**

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**(TOTAL FOR QUESTION 9 = 13 MARKS)**

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**TOTAL FOR PAPER = 90 MARKS**  
**END**