Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Thursday 13 June 2019

Morning (Time: 1 hour 45 minutes) | Paper Reference **9BI0/02**

Biology B

Advanced

Paper 2: Advanced Physiology, Evolution and Ecology

You must have:
Calculator, HB pencil, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- 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.

Information

- 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

- 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 ▶

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Pearson

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 ☒.

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

© Tim Macpherson, Cultura/Science photo library

© BSIP Laurent/Gluck/Science photo library

The pigment melanin causes the fur to turn black.
This pigment is produced by tyrosinase, an enzyme coded by the TYR gene.

$$\text{tyrosine} \xrightarrow{\text{tyrosinase}} \text{melanin}$$

(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

Complete the diagram to show the messenger RNA produced by the transcription of this DNA.

(1)

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

Which term describes this property of the genetic code?

(1)

☒ **A** degenerate

☒ **B** non-overlapping

☒ **C** triplet code

☒ **D** universal

(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)

☒ **A** hydrogen only

☒ **B** hydrogen and ionic

☒ **C** ionic and disulfide

☒ **D** ionic only

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

(3)

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(Total for Question 1 = 6 marks)

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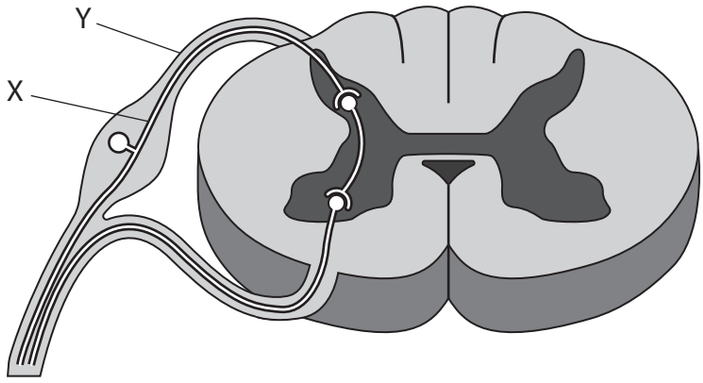
2 (a) (i) The diagram shows a section through the spinal cord.



Which row correctly names the structures labelled X and Y?

(1)

	X	Y
☒ **A**	motor neurone	dorsal root
☒ **B**	motor neurone	ventral root
☒ **C**	sensory neurone	dorsal root
☒ **D**	sensory neurone	ventral root

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

(1)

☒ **A** cerebellum

☒ **B** cerebrum

☒ **C** hypothalamus

☒ **D** medulla oblongata

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

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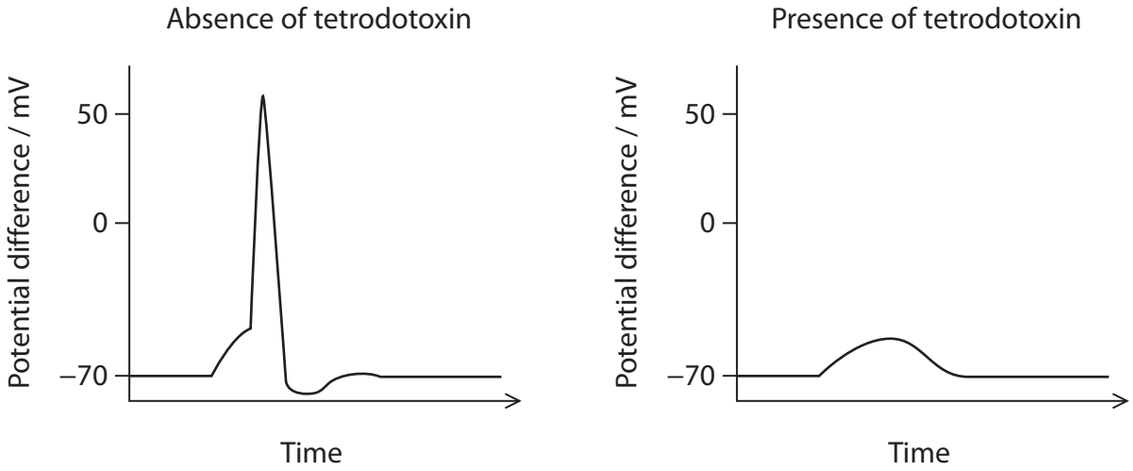
(c) The photograph shows a blue-ringed octopus.

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.

The graphs show the results of this investigation.



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Comment on how tetrodotoxin affects the potential difference of a neurone when the prey of the octopus is paralysed.

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(Total for Question 2 = 10 marks)

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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)

☒ **A** Ebola virus

☒ **B** human immunodeficiency virus (HIV)

☒ **C** λ (lambda) phage

☒ **D** tobacco mosaic virus

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

(i) Describe the lytic cycle of a virus.

(2)

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

State what is meant by the term latency.

(2)

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(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.

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	

Analyse the data to assess the effectiveness of Zmapp to treat patients with Ebola virus.

(4)

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(Total for Question 3 = 9 marks)

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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).

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

(1)

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(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)

☒ **A** AaBb × AaBb

☒ **B** aaBB × aaBB

☒ **C** AABb × AABB

☒ **D** aaBb × aaBb

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(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.

Using a genetic diagram, determine the probability that this cross will produce grains that are wrinkled and purple.

(4)

Answer .....

(Total for Question 4 = 6 marks)

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5 Chemical control in plants involves plant growth substances.

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

(1)

1 cell elongation

2 suppression of lateral bud growth

3 photomorphogenesis

☒ **A** 1 and 2

☒ **B** 1 and 3

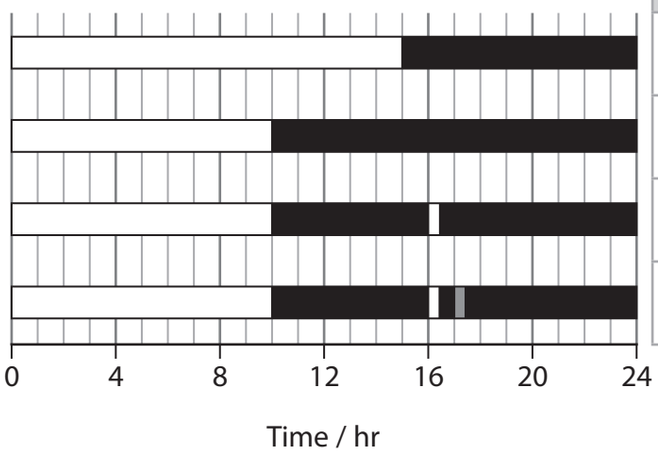
☒ **C** 2 and 3

☒ **D** 1, 2 and 3

*(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 shows the results of this investigation.



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

Key

light

dark

far red light

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.

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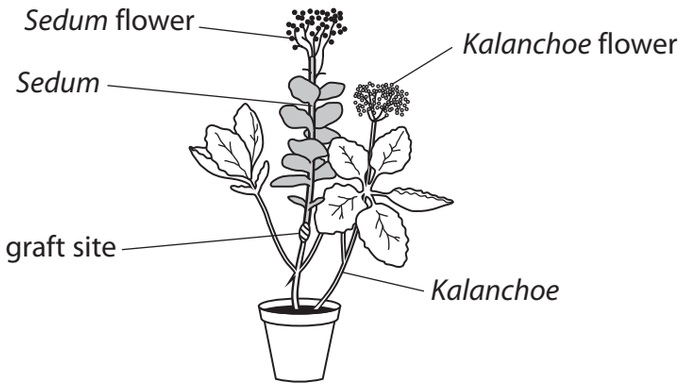

Analyse the data to explain the effects of different light periods and far red light on flowering in *Kalanchoe* and *Sedum*.

(6)

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(Total for Question 5 = 7 marks)

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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.

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
Guam flycatcher	6	23	11	0	0	0
Rufous fantail	74	55	43	0	0	0
Micronesian starling	148	159	135	71	7	0
Micronesian honeyeater	31	31	33	2	0	0
Bridled white-eye	108	98	2	0	0	0
Index of diversity (D)	4.6	4.7	4.1	3.5		0.0

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

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

(3)

Answer .....

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

(2)

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

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(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)

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

Describe how seed banks are used as a method of conservation.

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(Total for Question 6 = 15 marks)

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

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

(1)

☒ **A** condensation reaction breaking glycosidic bonds

☒ **B** condensation reaction breaking phosphodiester bonds

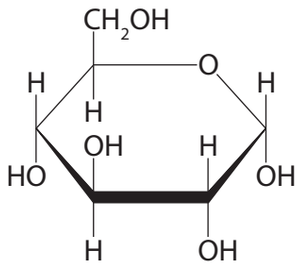
☒ **C** hydrolysis reaction breaking glycosidic bonds

☒ **D** hydrolysis reaction breaking phosphodiester bonds

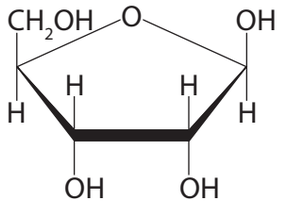
(ii) Which diagram shows the structure of the glucose produced?

(1)

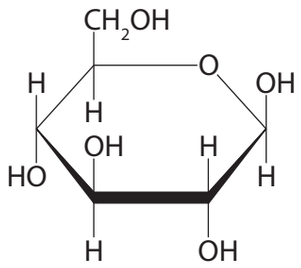
☒ **A**



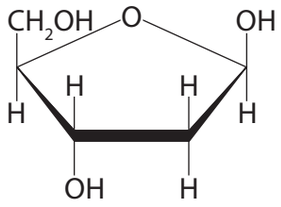
☒ **C**



☒ **B**



☒ **D**



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

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(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)

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(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.

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

Use the Hardy-Weinberg equation

(4)

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

Answer .....

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(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.

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(Total for Question 7 = 14 marks)

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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

vulkaner.no

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)

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(ii) Explain how ecosystems have developed on Surtsey since 1965.

(5)

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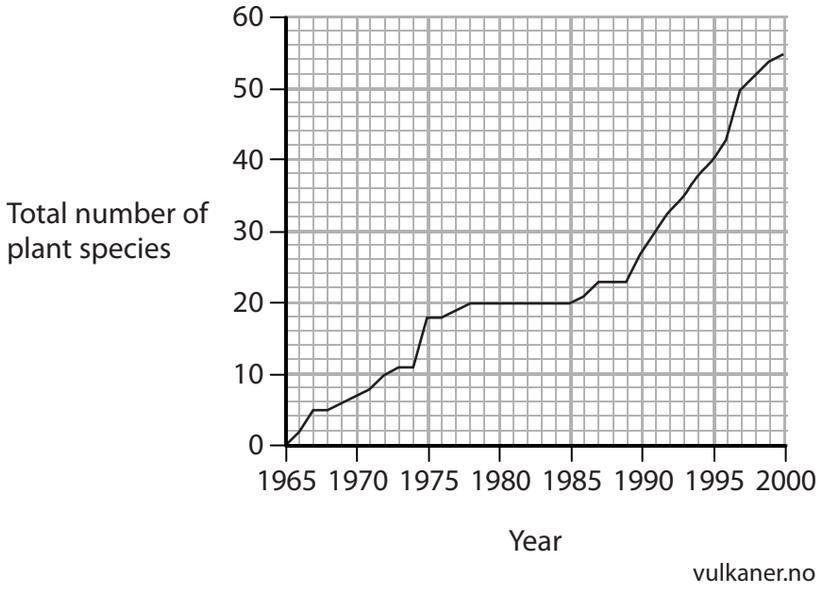
(b) The scientists recorded the number of different plant species on the island each year from 1965 to 2000.

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

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



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)

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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

(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)

☒ **A** covalent

☒ **B** ionic

☒ **C** hydrogen

☒ **D** hydrophobic

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(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

(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

(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

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(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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*(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.

Graph 1 and Graph 2 show the results of this investigation.

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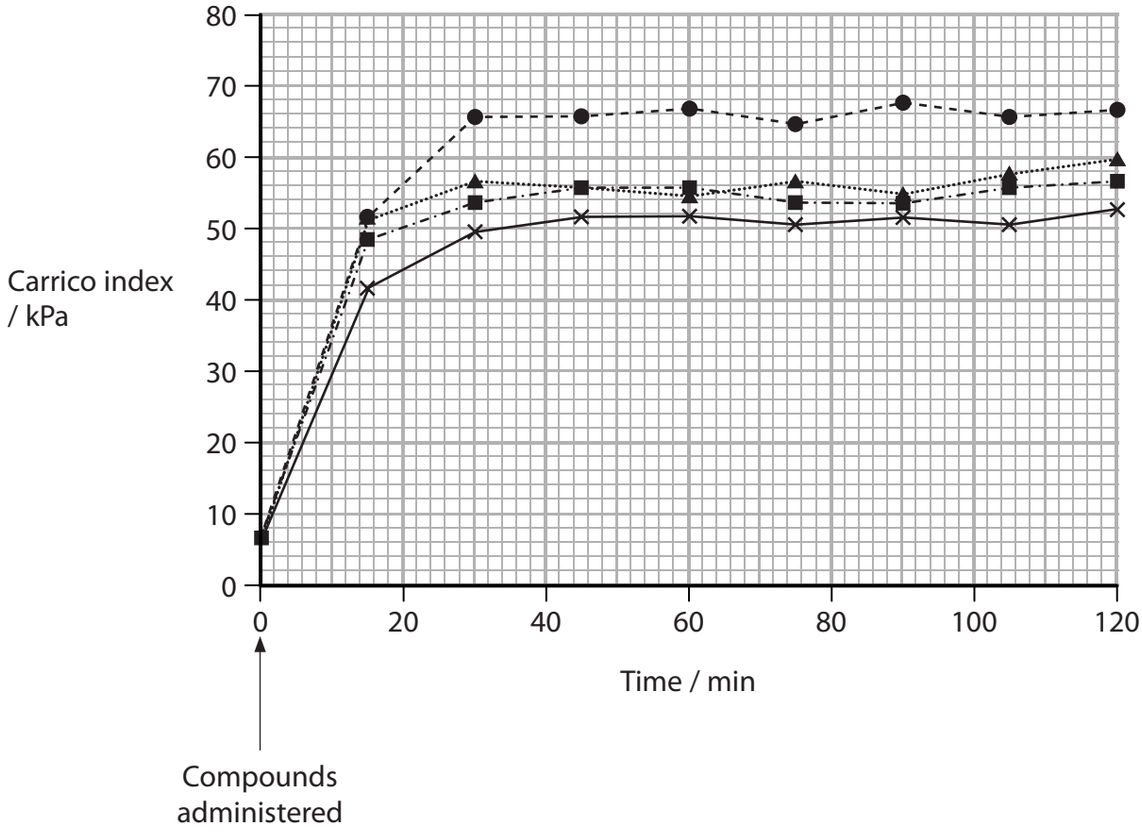
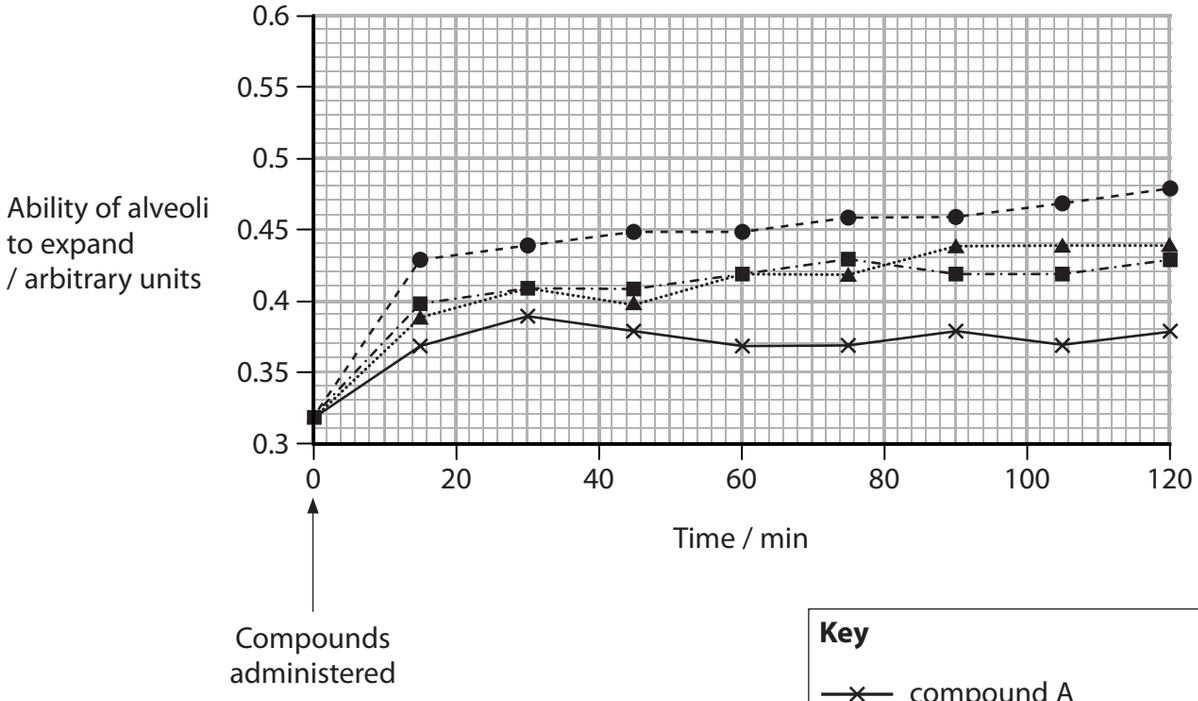
Graph 1 Effect of compounds A and B on the Carrico index



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



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Analyse the data to explain the potential use of these two compounds to treat ARDS in human babies.

(6)

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(Total for Question 9 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

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