Cambridge Pre-U

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

9891123490

BIOLOGY **9790/02**

Paper 2 Long Answer **May/June 2013**

2 hours 45 minutes

Candidates answer on the Question Paper.

No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section C
Answer **one** question.
Write your answer on the Question Paper. Separate answer paper will be available if required.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
8	
9	
10	
Total	

This document consists of **26** printed pages and **2** blank pages.

Section A

For Examiner's Use

Answer **all** the questions.

You are advised to spend no more than 65 minutes on this section.

Data Analysis

1 A large scale international study was carried out into the effectiveness of a type of statin in reducing the risk of major cardiovascular events, including stroke. The people taking part in the study were given either the statin or a placebo (a pill with no statin). The percentage of those who subsequently had a stroke or other major cardiovascular event was recorded. The results are shown in Table 1.1.

Table 1.1

	percentage of people having a stroke or other major cardiovascular event		significance
	placebo	statin	
stroke	6	4	$p < 0.05$
other major cardiovascular events	25	20	$p < 0.05$

(a) Explain how statins are thought to reduce the risk of cardiovascular disease.

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(b) Explain the importance of using a placebo in this study.

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(c) Discuss any conclusions that may be drawn from this study.

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[Total: 8]

2 A type of pheasant occurs in a range of colours, especially when bred in captivity. It may, for example, have green or purple plumage.

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Sometimes when a green male is crossed with a green female all the offspring, male and female, are green. However, sometimes a green male crossed with a green female results in offspring in which the majority of the offspring are green, but in which some of the females are purple, as shown in Table 2.1.

Table 2.1

phenotype	number of offspring
green male	7
green female	3
purple female	4

(a) (i) Using the results shown in Table 2.1, a geneticist proposed a hypothesis which predicted a 3:1 ratio of green:purple phenotypes. She used the χ^2 test to test her hypothesis.

Complete Table 2.2 to calculate χ^2.

Table 2.2

	green plumage	purple plumage
observed (O)	7 + 3 = 10	4
expected (E)	10.5	3.5
$O - E$		
$(O - E)^2$		
$\frac{(O - E)^2}{E}$		

$\Sigma \frac{(O - E)^2}{E} = \chi^2$	

[2]

(ii) Draw a conclusion from your calculation in Table 2.2, given that the critical value for χ^2 at $p = 0.05$ with one degree of freedom is 3.84. Explain why this conclusion should be treated with caution.

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(b) Plumage colour in pheasants is sex-linked.

In birds, the sex chromosomes are referred to as W and Z, rather than Y and X as in mammals. The W chromosome has no genes that affect plumage colour. The heterogametic sex is the female, **not** the male. Thus the male has two Z chromosomes (ZZ) and the female has one W and one Z chromosome (WZ).

(i) Use a genetic diagram to explain the results in Table 2.1.

[3]

(ii) Using the same symbols as in **(b)(i)**, indicate the genotypes and phenotypes of the parents which could give rise to purple male offspring.

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[Total: 10]

3 The rate of carbon dioxide uptake at a range of carbon dioxide concentrations by barley, a C3 plant, and sugar cane, a C4 plant, were compared at two temperatures using the apparatus shown in Fig. 3.1.

The results of the experiment are presented in Fig. 3.2.

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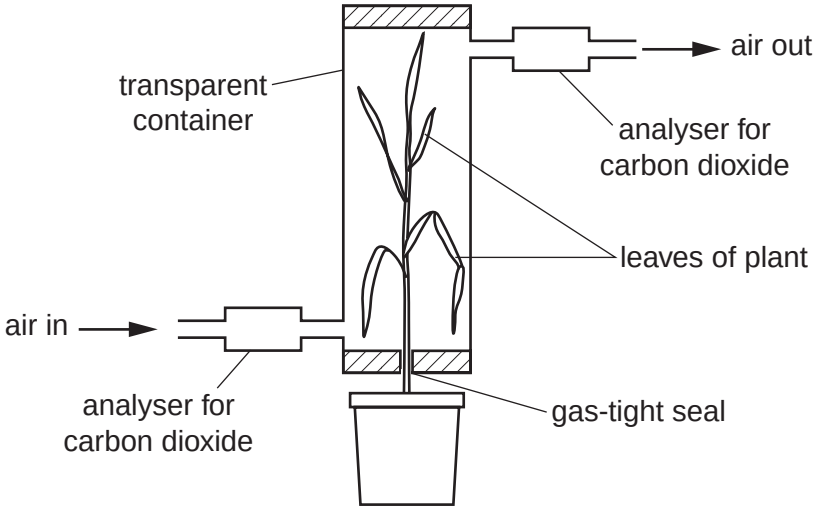

Fig. 3.1

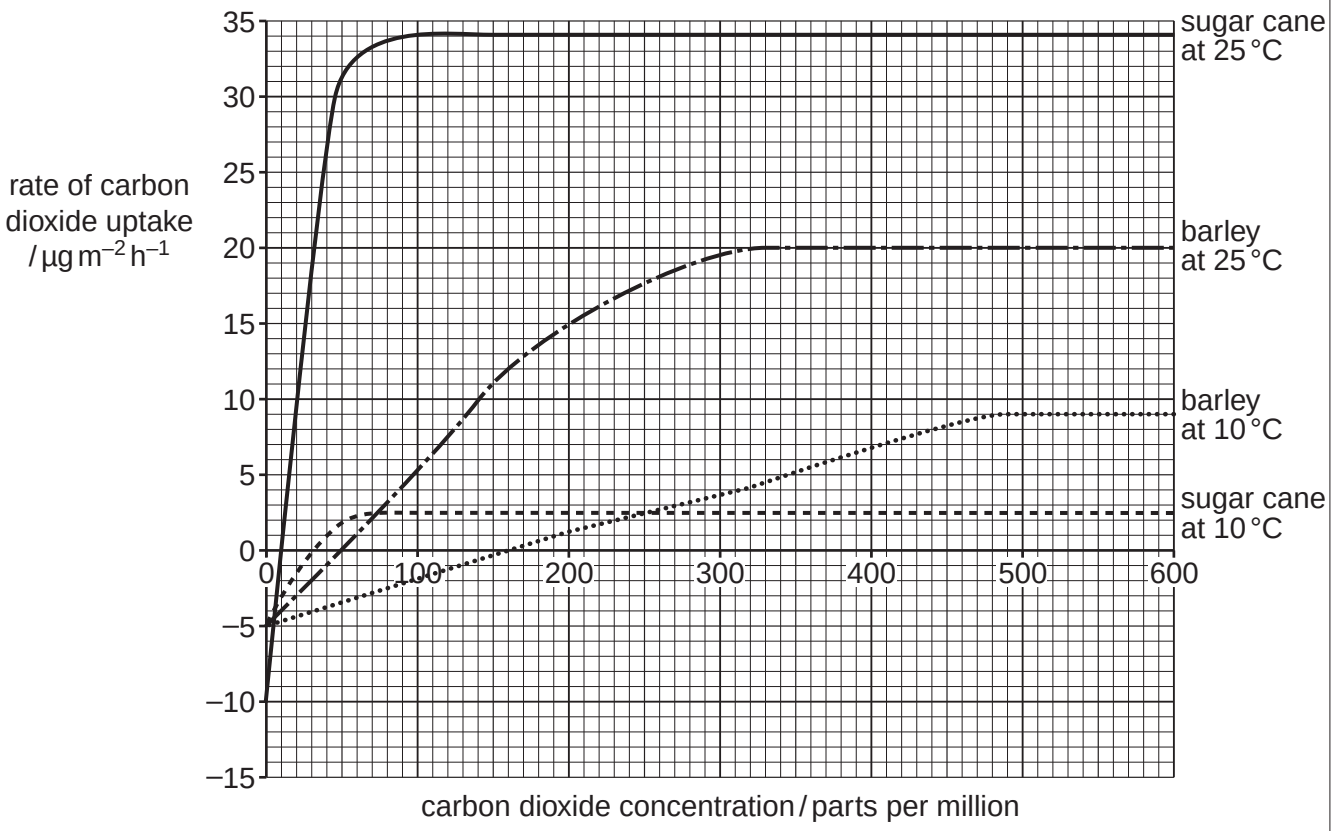

Fig. 3.2

Fig. 3.3 shows a key reaction in the light-independent stage of photosynthesis. One 5C molecule combines with one molecule of carbon dioxide to form two 3C molecules.

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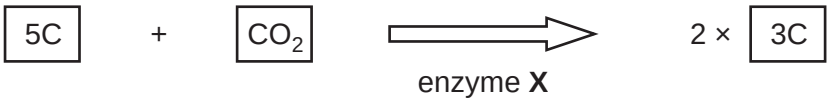

Fig. 3.3

(a) Name enzyme **X** and the 3C molecule.

enzyme **X** .....

3C molecule .....

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(b) With reference to Fig. 3.2, describe the differences in rates of carbon dioxide uptake by barley and sugar cane in response to increasing carbon dioxide concentrations at both 10 °C and 25 °C.

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(c) Explain why C3 plants and C4 plants respond differently to changes in carbon dioxide concentration.

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(d) Table 3.1 shows some data about six crop plants, three of which are C3 and three of which are C4.

Table 3.1

crop	C3 or C4	mass of water absorbed per gram dry mass produced / g
rice	C3	682
potato	C3	575
wheat	C3	542
maize	C4	350
sorghum	C4	304
millet	C4	285

Comment on the data shown in Table 3.1.

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(e) C4 plants constitute only 3% of flowering plant species yet they account for about 25% of global terrestrial primary productivity.

Fig. 3.4 shows the changes in atmospheric carbon dioxide concentration since 1959 measured at Mauna Loa Observatory in Hawaii. It is widely believed that the rising carbon dioxide concentration of the atmosphere is linked to increases in global mean surface temperature and that this, in turn, is resulting in climate change, such as changes in rainfall patterns.

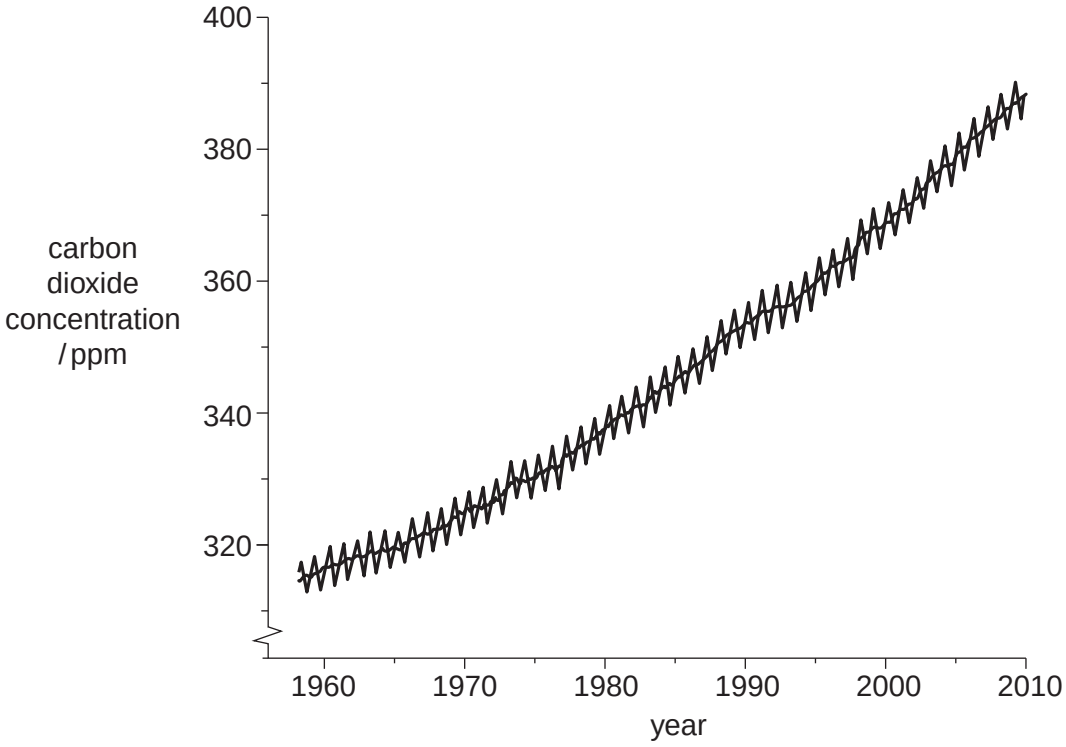

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Fig. 3.4

Discuss the likely impact of predicted changes in carbon dioxide concentration, global temperatures and rainfall patterns on the global distribution of C3 and C4 plants.

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The Planning Task

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4 The yield of many cultivated varieties of crop plants such as the onion, *Allium cepa*, is reduced by the presence of relatively high concentrations of salts, particularly sodium chloride, in the soil. There are, however, salt-tolerant varieties of onion which can be grown successfully in such places. One possible explanation for this is that the fluid in the cell vacuoles of plants of the tolerant varieties differs in solute potential from that of non-tolerant varieties.

Plan an investigation to find out whether or not the solute potentials of the cell vacuoles of epidermal cells of the bulbs of salt-tolerant onions differ from those of their non-tolerant counterparts.

You are provided with the following equipment. Choose your equipment from this list.
You may **not** use any additional equipment.

- an unlimited supply of 1.0 mol dm^{-3} sodium chloride solution
- an unlimited supply of bulbs of two varieties of onion, one salt tolerant and the other non salt tolerant
- unlimited supply of distilled or deionised water
- beakers of various sizes
- glass specimen tubes
- microscope slides and coverslips
- volumetric flasks and measuring cylinders of various sizes
- graduated pipettes of various sizes, and pipette fillers
- dropping pipettes
- light microscope with low (×100), medium (×200) and high (×400) magnification and built-in illumination
- wash bottle
- marker pen
- stop clock or bench timer
- scalpel
- forceps
- glass rods for stirring
- mounted needles
- iodine in potassium iodide solution

Your plan should

- include a clear statement of the hypothesis or prediction
- identify the key variables
- give full details and explanations of the procedures that you would adopt to ensure that the results are as precise and reliable as possible
- show how you would present and analyse your results
- include a brief risk assessment
- be written in clear scientific language.

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[Total: 22]

[Total for Section A: 60]

Section B

Read the passage carefully and answer **all** the questions.

You are advised to spend no more than 50 minutes on this section.

Adapted to survive in a harsh habitat

The Shetland Islands lie in the Atlantic 100 km north of mainland Scotland (Fig. 5.1). The Keen of Hamar (Fig. 5.2) is a rocky headland in northern Shetland where there are large areas of stony ground known as debris, which are almost bare of vegetation.

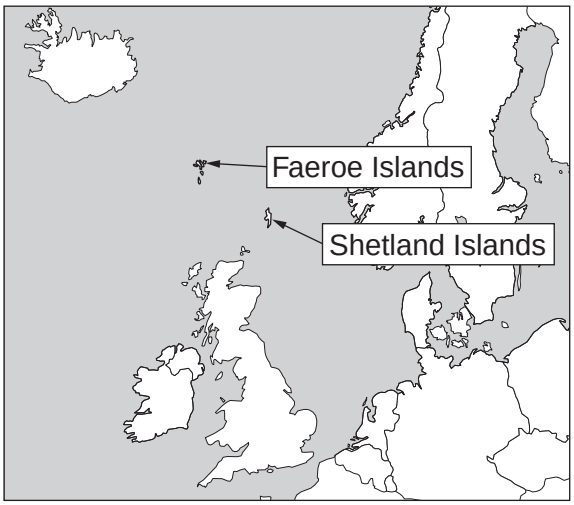

Fig. 5.1

Fig. 5.2

Fig. 5.3

Fig. 5.4

Shetland, the most northerly part of the UK, is only 400 km south of the Arctic Circle but it has an oceanic, rather than an arctic, climate with mild winters (relatively little frost) and cool summers. Most of Shetland is not bare like the Keen but is covered in vegetation, mainly grassland, heather moor and peat bog. The Keen is a Site of Special Scientific Interest (SSSI). The debris, with its shallow, nutrient-deficient, sandy, freely-draining soil may look bare, but quite a number of plant species grow amongst the small stones on the surface. Of particular scientific interest is the Shetland mouse-ear, *Cerastium nigrescens* (Fig. 5.3 and Fig. 5.4), which is almost entirely confined to the Keen debris. This species is believed to have always been restricted to this area, where it evolved in response to local environmental conditions.

The Shetland mouse-ear almost certainly evolved from the Arctic mouse-ear, *Cerastium arcticum*, a species which remains widespread on bare stony soil in the northern parts of Scandinavia, Russia, Siberia and North America. The nearest population of Arctic mouse-ear to the Keen is 200 km to the north-west, in the Faeroe Islands (Fig. 5.1).

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At the end of the last Ice Age, the Arctic mouse-ear is thought to have been widespread not only on Shetland, but also further south, growing on stony ground left bare by melting ice. Over the next few thousand years vegetation, such as forest, heath or grassland, spread north to cover most of the land. The Keen debris habitat was one of the exceptions to this and it remained bare despite no longer having an arctic climate. It has probably changed little in 10 000 years.

5 **(a)** Suggest **and** explain the possible advantages of the following distinctive features of the Shetland mouse-ear for its survival on the Keen of Hamar:

relatively large flowers .....

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leaves which are thick and very hairy .....

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relatively large seeds .....

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(b) Explain how the Shetland population of mouse-ear could have become a different species from the Arctic mouse-ear.

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[Total: 10]

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6 Between 1981 and 1982, hay was spread across small areas of the Keen debris to feed cattle in winter. When the animals congregated to eat the hay, they deposited dung on the debris and this represented a significant input of nutrients, such as phosphate (eutrophication). The effects of this were studied by marking out a number of areas of 4 m × 4 m = 16 m^2 with permanent markers (Fig. 6.1). Each area was divided into 16 quadrats of 1 m × 1 m. The density of Shetland mouse-ear plants was determined in each of these quadrats and the mean density calculated. The mean percentage cover of all plant species was estimated using the point quadrat method (Fig. 6.2).

Fig. 6.1

Fig. 6.2

Data were recorded on several occasions, before and after the eutrophication event, and the results from the sampled quadrats are presented in Table 6.1.

Table 6.1

	Year						
	1977	1980	1985	1987	1991	1993	2006
mean density of Shetland mouse-ear / plants per m^2	5	6	11	7	4	2	0
mean percentage total plant cover	10	11	68	71	56	67	76

(a) (i) As well as sampling the permanently marked quadrats, the researchers also used randomly placed quadrats across the whole of the Keen.

Suggest why they did this.

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(ii) Describe **and** explain the patterns shown by the data in Table 6.1.

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(iii) Suggest a suitable control for this study.

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(b) Suggest the priorities for the conservation of the Shetland mouse-ear.

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[Total: 11]

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7 **(a)** There have been times in the past when biologists have regarded *Cerastium nigrescens* and *C. arcticum* as different forms of the same species.

Describe how you would confirm that they are different species.

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(b) **(i)** The herring gull, *Larus argentatus*, and the lesser black-backed gull, *L. fuscus*, both occur on the Shetland Islands. These two species are regarded by some scientists as parts of a 'ring species' complex. These two species of gull do not interbreed on Shetland.

Explain what is meant by a ring species.

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(ii) Some biologists think that the lesser black-backed gull is spreading east to west from Shetland towards Canada.

How might this affect this ring species complex?

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(iii) Suggest why plant species, such as the Shetland mouse-ear, are less likely to be part of a ring species complex than the *Larus* gulls.

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[Total: 9]

[Total for Section B: 30]

Section C

For Examiner's Use

Answer **one** question on the lined paper that follows.

Credit will be given for answers that draw from a wide range of syllabus material and also for evidence of reading around the subject.

You are advised to spend no more than 50 minutes on this section.

8 It is believed that sperm were originally an adaptation for sexual reproduction in the marine environment, where life evolved. Many aquatic species of plants and animals reproduce by releasing male and female gametes into water. The sperm, the male gametes, swim to the ova and thus fertilisation takes place. Land plants and animals are thought to have evolved from marine ancestors. Some amphibians, such as frogs, return to water to reproduce where their sperm can swim to the ova, but most land plants and animals have evolved alternative strategies.

Discuss the problems involved in the transfer of male gametes on land, and the ways in which these problems have been solved in a range of organisms.

9 DNA molecules are replicated with a high degree of accuracy yet not always perfectly.

Describe how this occurs and discuss why the survival of a species depends on DNA molecules being stable, yet not *absolutely* stable.

10 'The roles of hormones in both plants and animals are essentially the same, but only animals need a nervous system.'

Discuss the extent to which this is a valid statement.

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[Total: 30]

[Total for Section C: 30]

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