Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2017**

1 hour 15 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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

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.

This document consists of **11** printed pages and **1** blank page.

CAMBRIDGE International Examinations

1 Fig. 1.1 shows an aquatic crustacean belonging to the genus *Daphnia*. These animals usually measure between 1–5 mm in length. They have a two-chambered heart which can be seen through the exoskeleton when viewed using a low-powered microscope.

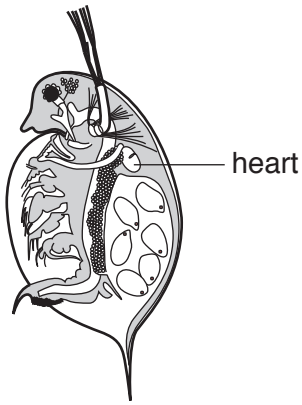

Fig. 1.1

A biology teacher told a class that caffeine can temporarily relieve tiredness in people by increasing heart rate.

Table 1.1 shows the caffeine content of various products.

Table 1.1

product	caffeine per serving / mg
1 cup of strong coffee	100
50 g dark chocolate	45
1 caffeine tablet	50
1 can of cola drink	20

One group of students in the class used *Daphnia* to test the hypothesis:

Heart rate increases when caffeine concentration increases.

(a) Identify the independent **and** dependent variable in this investigation.

independent .....

dependent ..... [2]

The group of students decided to use the caffeine tablets to make a 100 mg dm^{-3} caffeine solution.

(b) (i) Describe a procedure that the students should use to prepare the 100 mg dm^{-3} caffeine solution.

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..... [2]

A culture of healthy *Daphnia* was supplied to the students in a tank containing fresh water and a suitable food source.

Each student followed the same basic procedure.

- A *Daphnia* was placed on some cotton wool fibres in a cavity microscope slide as shown in Fig. 1.2.
- A few drops of 100 mg dm^{-3} caffeine solution were immediately added to the slide.
- The *Daphnia* was observed using the low power objective lens of a microscope.
- The number of heart beats of the *Daphnia* was counted.

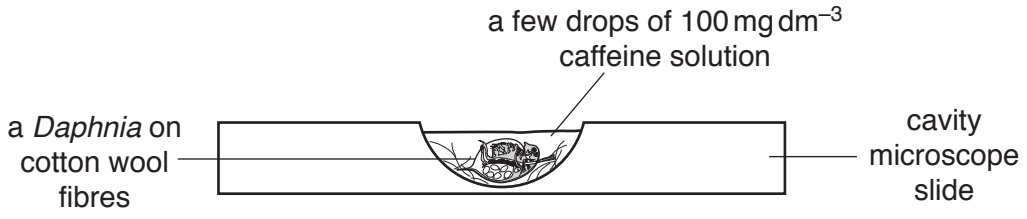

Fig. 1.2

(ii) Suggest **one** reason why the *Daphnia* was placed on cotton wool fibres.

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..... [1]

(iii) The students decided to adapt their basic procedure to test their hypothesis that:

Heart rate increases when caffeine concentration increases.

Describe a method which the students could use to test this hypothesis.
Your method should be detailed enough for another person to follow.

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(iv) Suggest **one** feature of the procedure which may have added a source of error and suggest how the students could have reduced its effect.

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..... [2]

The data the students obtained showed that as the concentration of caffeine increased, the heart rate of the *Daphnia* also increased.

The students concluded:

To relieve tiredness, people should increase their caffeine intake so that their heart rate will increase.

(c) Suggest why the students' conclusion was **not** valid.

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..... [1]

Another group of students decided to use cola as their source of caffeine. They diluted the cola to give a range of caffeine concentrations. They counted the heart rates of *Daphnia* in each of these concentrations.

Table 1.2 shows their results.

Table 1.2

concentration of caffeine / mg 100 cm^{-3}	heart rate of *Daphnia* / beats per minute					
	1	**2**	**3**	**4**	**5**	**mean**
2.4	307	284	228	275	301	279
3.6	325	331	319	328	322	325
4.8	361	355	349	358	362	357
6.0	377	365	357	360	363	364

(d) **(i)** On Table 1.2 indicate, by placing a circle around the value, **one** result that may be anomalous. [1]

These students concluded that:

The heart rate of *Daphnia* increased proportionally to the concentration of caffeine.

(ii) Suggest **two** reasons why the data collected was **not** sufficient to make this conclusion.

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..... [2]

[Total: 17]

2 Some populations of white clover, *Trifolium repens*, are described as cyanogenic because they produce hydrogen cyanide.

Hydrogen cyanide is a poison which inhibits respiration and reduces grazing by herbivores.

A group of scientists investigated the percentage of cyanogenic plants in populations of *T. repens* growing in different locations. The mean January temperature was also recorded.

Table 2.1 shows the results of their investigation.

Table 2.1

location	percentage of cyanogenic *T. repens*	mean January temperature /°C
Almora, India	85	12.2
Fairbanks, Alaska, USA	5	– 23.9
Karaj River, Iran	64	4.4
Konosu, Japan	50	4.2
Lennoxville, Quebec, Canada	71	– 10.0
Mandan, North Dakota, USA	33	– 12.8
Novosibirsk, Russia	0	– 19.4
Pretoria, South Africa	68	10.0
Rabat, Morocco	100	12.5

The scientists calculated the Spearman's rank correlation coefficient to test the hypothesis:

The proportion of cyanogenic plants in populations of *T. repens* increases as the mean January temperature increases.

(a) State a null hypothesis for this test.

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..... [1]

(b) The formula for Spearman's rank correlation is

$$r_s = 1 - \left(\frac{6 \times \Sigma D^2}{n^3 - n}\right)$$

n = number of pairs of items in the sample

D = difference between each pair of ranked measurements

(i) Complete Table 2.2 to show how the values for D^2 were calculated. [2]

Table 2.2

location	percentage of cyanogenic *T. repens* plants	rank of percentage of cyanogenic *T. repens* plants	mean January temperature /°C	rank of mean January temperature	difference in rank, D	D^2
Almora	85		12.2	8		0
Fairbanks	5		–23.9	1		1
Karaj River	64		4.4	6		1
Konosu	50		4.2	5		1
Lennoxville	71		–10.0	4		9
Mandan	33		–12.8	3		0
Novosibirsk	0		–19.4	2		1
Pretoria	68		10.0	7		1
Rabat	100		12.5	9		0
					ΣD^2 =	14

(ii) Complete the steps of the calculation to find the value of r_s. Give your answer to two decimal places.

$$r_s = 1 - \left(\frac{6 \times 14}{\text{.....}^3 - \text{.....}}\right)$$

$$r_s = 1 - \left(\frac{84}{\text{.....}}\right)$$

$$r_s = 1 - \text{.....}$$

r_s = ... (2 d.p.) [2]

Table 2.3 shows the critical values of r_s at the 0.05 probability level.

Table 2.3

n	5	6	7	8	9	10	11	12	14	16
critical value of r_s	1.00	0.89	0.79	0.76	0.68	0.65	0.60	0.54	0.51	0.51

(iii) Explain why the scientists rejected the null hypothesis.

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(iv) Suggest why there is a higher proportion of cyanogenic clover plants at locations with high mean January temperatures compared with the other locations studied.

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..... [1]

[Total: 7]

Question 3 starts on page 10

3 An investigation was carried out into the population of a species of vole in one area of the USA. The population was sampled during the first two weeks of August between 1983 and 2004. Traps for catching small mammals were placed at equal distances along the same parallel line transects. Each year, the number of voles caught per 1000 traps was recorded.

Fig. 3.1 shows the results.

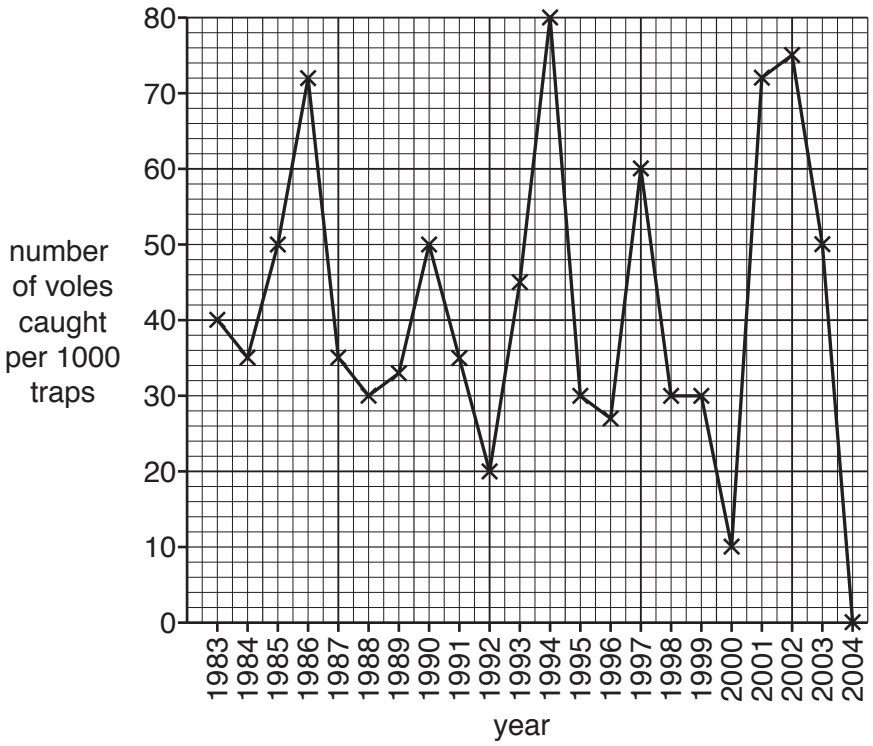

Fig. 3.1

(a) Identify three ways in which this investigation has been standardised.

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2 .....

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3 .....

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..... [3]

(b) Over the period of the study, it was found that 8 out of every 50 voles in this population had black fur, whilst all the other voles had brown fur.

Fur colour in voles is controlled by a single gene, **A**/**a**. Voles with black fur have the genotype **aa**.

The Hardy-Weinberg principle states that:

$p + q = 1$

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

p = the frequency of the dominant allele

q = the frequency of the recessive allele

Use the Hardy-Weinberg principle to calculate the expected number of voles heterozygous for fur colour that were recorded in 1997.

Give your answer to the nearest whole number.

number of voles per 1000 traps which are heterozygous for brown fur in 1997 = ...[3]

[Total: 6]

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