Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

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*0969986329 2*

**BIOLOGY** **9700/51**

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

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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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.
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**1** A student used the internet to find information about caffeine and the possible effects it has on the body.

The student decided to test the hypothesis that:

*Caffeine decreases the reaction time and increases the heart rate.*

Table 1.1 shows the results of the student's research into the caffeine content of drinks.

**Table 1.1**

| drink | cup of coffee | cup of tea | 100 $cm^3$ energy drink | 350 $cm^3$ cola |
|---|---|---|---|---|
| caffeine content / mg | 80 | 40 | 30 | 45 |

The student also found that it takes about 45 minutes before caffeine from a drink is fully absorbed into the blood and about 4 to 5 hours for the effect to wear off.

After further research, the student decided:

- test subjects should not know whether they are having a drink with caffeine or without caffeine
- drinks with caffeine and without caffeine should look identical
- to measure the subject's reaction time using a computer programme that flashes a coloured light at random intervals. The subject presses a switch as soon as they see the light
- to measure the heart rate using a pulse meter attached to the first finger.

**(a)** Suggest why it is important that the test subjects should not know whether they are having a drink with caffeine or without caffeine.

.....

..... [1]

**(b) (i)** State the independent variable and the **two** dependent variables in this investigation.

*independent variable* .....

.....

*dependent variables* .....

.....[2]

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**(ii)** Use the information given to describe a method by which the student could test their hypothesis using **one** of the drinks.

Your method should be detailed enough for another person to follow.

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**(c)** In another experiment 10 subjects were each given a different concentration of caffeine. The reaction time was measured 5 times for each subject and a mean calculated.

Table 1.2 shows the results.

**Table 1.2**

| subject | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| concentration of caffeine / mg dm$^{-3}$ | 0 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| mean reaction time / ms | 355 | 343 | 340 | 321 | 300 | 305 | 288 | 252 | 242 | 204 |

Fig. 1.1 shows the graph produced by a computer programme for the data.

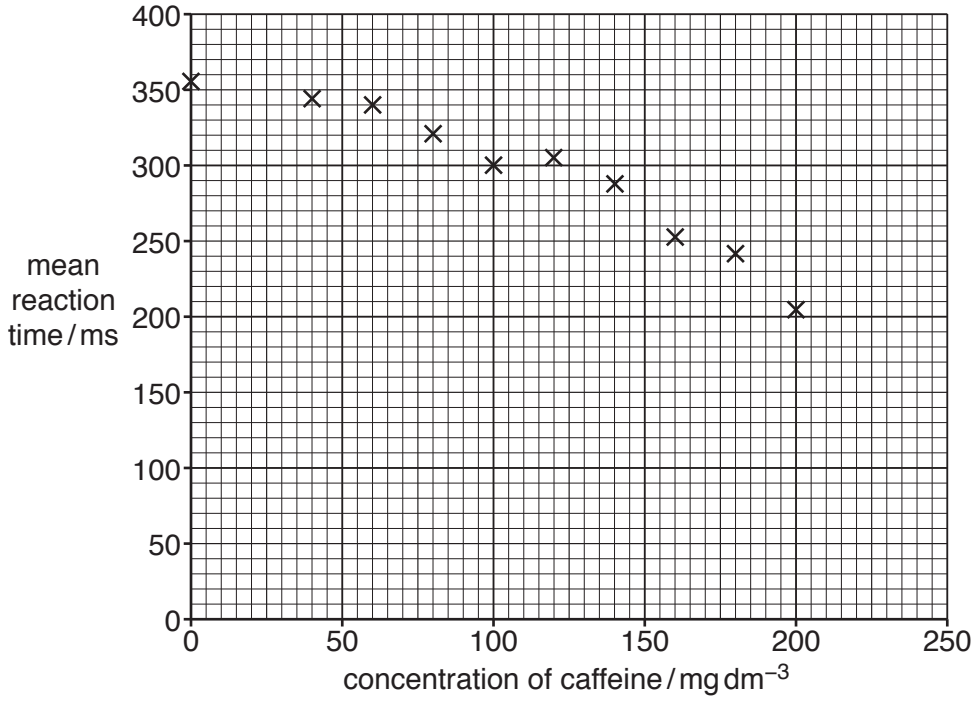



**Fig. 1.1**

Based on this graph the student decided to use a statistical test to find the strength of the correlation between the concentration of caffeine and the mean reaction time.

**(i)** State why Pearson's linear correlation test is suitable for the data.

.....

.....

..... [1]

**(ii)** The results of the statistical test gave Pearson's linear correlation, $r = -0.722$.

State what this value indicates about the relationship between the concentration of caffeine and the mean reaction time.

.....

.....[1]

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Table 1.3 shows part of a table of critical values for Pearson's linear correlation test (***r***).

**Table 1.3**

| number of pairs of data ($n$) | probability level ($p$) | | | |
|---|---|---|---|---|
| | **0.10** | **0.05** | **0.02** | **0.01** |
| 1 | 0.988 | 0.997 | 0.9995 | 0.9999 |
| 2 | 0.900 | 0.950 | 0.980 | 0.990 |
| 3 | 0.805 | 0.878 | 0.934 | 0.959 |
| 4 | 0.729 | 0.811 | 0.882 | 0.917 |
| 5 | 0.669 | 0.754 | 0.833 | 0.874 |
| 6 | 0.622 | 0.707 | 0.789 | 0.834 |
| 7 | 0.582 | 0.666 | 0.750 | 0.798 |
| 8 | 0.549 | 0.632 | 0.716 | 0.765 |
| 9 | 0.521 | 0.602 | 0.685 | 0.735 |
| 10 | 0.497 | 0.576 | 0.658 | 0.708 |

**(iii)** Describe how the student calculated the degrees of freedom.

.....

..... [1]

**(iv)** Describe how the student used the probability table to find out if the value for $r = 0.722$ is significant.

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..... [3]

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**[Turn over**

**(d)** Suggest **two** reasons why the method used for the investigation into the effect of caffeine concentration may have given results that are **not** reliable.

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..... [2]

**(e)** Effects of caffeine in the body include the promotion of acetylcholine release and the inhibition of acetylcholinesterase.

Suggest how this could account for the results in Table 1.2.

.....

.....

..... [1]

[Total: 20]

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**Question 2 starts on page 8**

**2** An investigation was carried out into the size of individuals in a species of ground beetle common in Europe. Five different sites, **A** to **E**, were sampled during the three warmest months of the year.

Table 2.1 shows information about the temperature at these sites.

**Table 2.1**

| site | **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|---|
| average yearly temperature / °C | 10.6 | 9.0 | 15.3 | 16.5 | 22.4 |
| lowest average temperature / °C | –2.1 | –1.3 | 8.1 | 1.5 | 16.1 |
| highest average temperature / °C | 23.6 | 21.5 | 23.4 | 28.5 | 29.6 |

- The population at each site was sampled a total of 10 times during the three month period.
- The beetles were sampled at 20 different locations within each site, on the same day.
- The length of each captured beetle was measured to the nearest mm as a measurement of body size.
- The beetles were divided into two groups according to body size, large and small.
- The results from the different locations in each site were added together.
- The population size and the percentages of large and small beetles in the population were estimated.

**(a) (i)** State two variables which have been standardised in this investigation.

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.....[2]

**(ii)** Outline how the population size of the beetles can be estimated.

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**(b)** Table 2.2 shows the results of the investigation.

**Table 2.2**

| site | **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|---|
| population of beetles | 10792 | 11314 | 18426 | 15224 | 17650 |
| number of large beetles | 6520 | 6276 | 10687 | 6432 | 6523 |
| number of small beetles | 4272 | 5038 | | 8792 | 11127 |
| percentage of large beetles | 60 | | 58 | 42 | 37 |

**(i)** Complete Table 2.2 by filling in the missing values for sites **B** and **C**. [2]

**(ii)** State, with a reason, whether these results support the hypothesis:

The body size of individuals in populations of ground beetles increases as the environmental temperature decreases.

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**(c)** State two **other** conclusions that can be made about the effect of temperature on body size of the beetles.

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**(d)** Predict **one** way in which climate change may influence the populations of these ground beetles.

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[Total: 10]

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Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

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|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | |

*7703370722*

**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**

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**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.

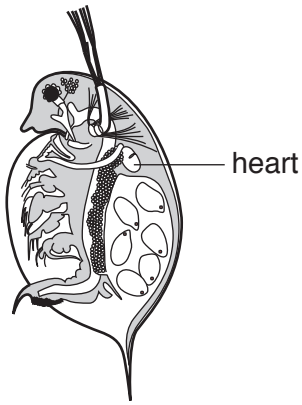



**Fig. 1.1**

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.

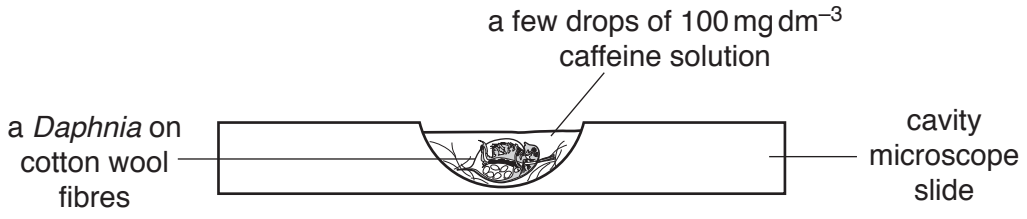



**Fig. 1.2**

**(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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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 |
| | | | | | $\Sigma D^2$ = | 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]

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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.

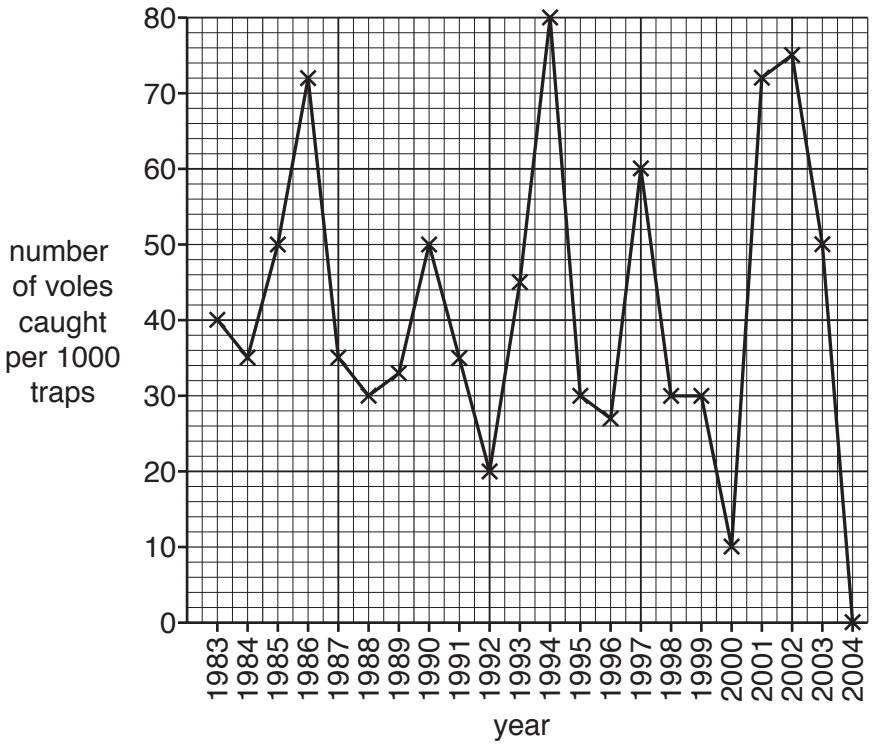



**Fig. 3.1**

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

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**(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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**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

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CANDIDATE NUMBER | | | | |

*2437208772*

**BIOLOGY** **9700/53**

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

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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**1** A student used the internet to find information about caffeine and the possible effects it has on the body.

The student decided to test the hypothesis that:

*Caffeine decreases the reaction time and increases the heart rate.*

Table 1.1 shows the results of the student's research into the caffeine content of drinks.

**Table 1.1**

| drink | cup of coffee | cup of tea | 100 $cm^3$ energy drink | 350 $cm^3$ cola |
|---|---|---|---|---|
| caffeine content / mg | 80 | 40 | 30 | 45 |

The student also found that it takes about 45 minutes before caffeine from a drink is fully absorbed into the blood and about 4 to 5 hours for the effect to wear off.

After further research, the student decided:

- test subjects should not know whether they are having a drink with caffeine or without caffeine
- drinks with caffeine and without caffeine should look identical
- to measure the subject's reaction time using a computer programme that flashes a coloured light at random intervals. The subject presses a switch as soon as they see the light
- to measure the heart rate using a pulse meter attached to the first finger.

**(a)** Suggest why it is important that the test subjects should not know whether they are having a drink with caffeine or without caffeine.

.....

..... [1]

**(b) (i)** State the independent variable and the **two** dependent variables in this investigation.

*independent variable* .....

.....

*dependent variables* .....

.....[2]

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**(ii)** Use the information given to describe a method by which the student could test their hypothesis using **one** of the drinks.

Your method should be detailed enough for another person to follow.

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**(c)** In another experiment 10 subjects were each given a different concentration of caffeine. The reaction time was measured 5 times for each subject and a mean calculated.

Table 1.2 shows the results.

**Table 1.2**

| subject | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| concentration of caffeine / mg dm$^{-3}$ | 0 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 |
| mean reaction time / ms | 355 | 343 | 340 | 321 | 300 | 305 | 288 | 252 | 242 | 204 |

Fig. 1.1 shows the graph produced by a computer programme for the data.

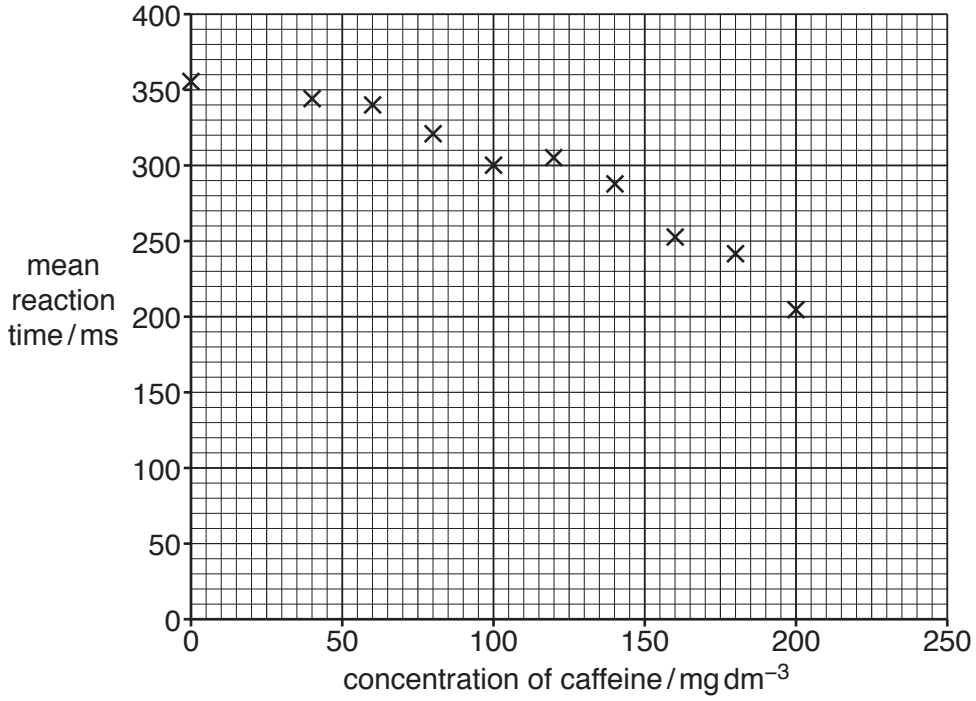



**Fig. 1.1**

Based on this graph the student decided to use a statistical test to find the strength of the correlation between the concentration of caffeine and the mean reaction time.

**(i)** State why Pearson's linear correlation test is suitable for the data.

.....

.....

..... [1]

**(ii)** The results of the statistical test gave Pearson's linear correlation, $r = -0.722$.

State what this value indicates about the relationship between the concentration of caffeine and the mean reaction time.

.....

.....[1]

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Table 1.3 shows part of a table of critical values for Pearson's linear correlation test (***r***).

**Table 1.3**

| number of pairs of data ($n$) | probability level ($p$) | | | |
|---|---|---|---|---|
| | **0.10** | **0.05** | **0.02** | **0.01** |
| 1 | 0.988 | 0.997 | 0.9995 | 0.9999 |
| 2 | 0.900 | 0.950 | 0.980 | 0.990 |
| 3 | 0.805 | 0.878 | 0.934 | 0.959 |
| 4 | 0.729 | 0.811 | 0.882 | 0.917 |
| 5 | 0.669 | 0.754 | 0.833 | 0.874 |
| 6 | 0.622 | 0.707 | 0.789 | 0.834 |
| 7 | 0.582 | 0.666 | 0.750 | 0.798 |
| 8 | 0.549 | 0.632 | 0.716 | 0.765 |
| 9 | 0.521 | 0.602 | 0.685 | 0.735 |
| 10 | 0.497 | 0.576 | 0.658 | 0.708 |

**(iii)** Describe how the student calculated the degrees of freedom.

.....

..... [1]

**(iv)** Describe how the student used the probability table to find out if the value for $r = 0.722$ is significant.

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..... [3]

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**[Turn over**

**(d)** Suggest **two** reasons why the method used for the investigation into the effect of caffeine concentration may have given results that are **not** reliable.

.....

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.....

..... [2]

**(e)** Effects of caffeine in the body include the promotion of acetylcholine release and the inhibition of acetylcholinesterase.

Suggest how this could account for the results in Table 1.2.

.....

.....

..... [1]

[Total: 20]

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**Question 2 starts on page 8**

**2** An investigation was carried out into the size of individuals in a species of ground beetle common in Europe. Five different sites, **A** to **E**, were sampled during the three warmest months of the year.

Table 2.1 shows information about the temperature at these sites.

**Table 2.1**

| site | **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|---|
| average yearly temperature / °C | 10.6 | 9.0 | 15.3 | 16.5 | 22.4 |
| lowest average temperature / °C | –2.1 | –1.3 | 8.1 | 1.5 | 16.1 |
| highest average temperature / °C | 23.6 | 21.5 | 23.4 | 28.5 | 29.6 |

- The population at each site was sampled a total of 10 times during the three month period.
- The beetles were sampled at 20 different locations within each site, on the same day.
- The length of each captured beetle was measured to the nearest mm as a measurement of body size.
- The beetles were divided into two groups according to body size, large and small.
- The results from the different locations in each site were added together.
- The population size and the percentages of large and small beetles in the population were estimated.

**(a) (i)** State two variables which have been standardised in this investigation.

1 .....

.....

2 .....

.....[2]

**(ii)** Outline how the population size of the beetles can be estimated.

.....

.....

.....

.....

..... [2]

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**(b)** Table 2.2 shows the results of the investigation.

**Table 2.2**

| site | **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|---|
| population of beetles | 10792 | 11314 | 18426 | 15224 | 17650 |
| number of large beetles | 6520 | 6276 | 10687 | 6432 | 6523 |
| number of small beetles | 4272 | 5038 | | 8792 | 11127 |
| percentage of large beetles | 60 | | 58 | 42 | 37 |

**(i)** Complete Table 2.2 by filling in the missing values for sites **B** and **C**. [2]

**(ii)** State, with a reason, whether these results support the hypothesis:

The body size of individuals in populations of ground beetles increases as the environmental temperature decreases.

.....

.....

..... [1]

**(c)** State two **other** conclusions that can be made about the effect of temperature on body size of the beetles.

1 .....

.....

.....

2 .....

.....

.....[2]

**(d)** Predict **one** way in which climate change may influence the populations of these ground beetles.

.....

..... [1]

[Total: 10]

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