Cambridge International AS & A Level

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

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

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

MARK SCHEME

Maximum Mark: 30

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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**Mark scheme abbreviations**

| | |
|---|---|
| **;** | separates marking points |
| **/** | alternative answers for the same point |
| **R** | reject |
| **A** | accept (for answers correctly cued by the question, or guidance for examiners) |
| **I** | ignore (for answers that include irrelevant information that does not contradict the expected answer) |
| **AW** | alternative wording (where responses vary more than usual) |
| **ora** | or reverse argument (for answers which are written as the opposite to the expected answer) |
| **underline** | actual word given must be used by candidate (grammatical variants accepted) |
| **max** | indicates the maximum number of marks that can be given |
| **ecf** | error carried forward |
| **mp** | marking point (with relevant number) |

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| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 1(a) | *idea that,* results / they / it / test, could be affected by subject expectation / AW **;** | **1** | **A** 'results' in terms of, heart beat / heart rate / pulse rate / reaction time AW<br>**I** may affect results / fair test / *ref. to* reliable results unqualified |
| 1(b)(i) | *independent variable*<br>presence (or absence) of caffeine **;**<br><br>*dependent variables*<br>heart rate **and,** reaction / response, time **;** | **2** | **A** caffeine concentration / volume of caffeine<br>**A** pulse rate / number of (heart) beats per minute<br>**A** description of reaction time, e.g. time to press switch |
| 1(b)(ii) | *max 8 of:*<br>1. *ref. to* having a large number of test subjects / AW **;**<br><br>2. *ref. to* subjects / groups, have drinks with **and** without caffeine **;**<br><br>3. *ref. to* description of method of making drinks indistinguishable<br>**or**<br>*ref. to* method that only, experimenter / student, can tell which is which **;**<br><br>*procedure*<br>4. *ref. to* test-subjects not, drinking / taking in, any caffeine (drink) for at least 5 hours before the test **;**<br><br>5. *Idea that e*ach subject being tested in isolation / away from others (throughout the experiment) **;**<br><br>6. *ref. to* subject, at rest / quiet, during test / after test / whilst having measurements (reaction time **and** heart rate) taken **;**<br><br>7. *ref. to* taking measurements (of reaction time **and** heart rate) **before** giving the drink **;** | **8** | 1. if number stated, minimum of 10 with caffeine<br><br>2. **A** water / 0 mg caffeine / AW as decaffeinated drink |

| Question | Answer | Mark | Guidance |
|---|---|---|---|
| | 8. *ref. to* waiting (a minimum of) 45 minutes **after** giving the drink before measuring (the reaction time **and** heart rate) **;**<br><br>9. *ref. to* giving the same volume of drink (to all subjects) **;**<br><br>10. *ref. to* test subjects being, all caffeine / all non-caffeine, users **;**<br><br>11. *ref. to* test subjects being, same / similar, age / mass / weight / fitness level / ethnicity / race **;**<br><br>12. *idea of* standardised sex balance **;**<br><br>13. calculate mean (for the measurements) **;**<br><br>14. *ref. to idea that* health questionnaire / getting permission before testing / being aware of potential health risks<br>**or**<br>*ref. to* allowing test-subjects to stop if they feel unwell **;** | | 8. **A** other stated times **up to** 2 hours / 120 minutes<br>**R** around / about 45 minutes<br><br>9. **A** stated volumes, e.g. 100 – 350 $cm^3$ **A** 'a can' / 'a bottle' / 'a cup'<br><br>10: **I** *ref to*. paired sampling<br><br>11. **A** same age range (e.g. 35–40) **I** *ref. to* health here (see mp 14)<br><br>12. **A** have all of one sex / equal numbers of one sex<br><br>13. **I** average **A** repeat three times and take a mean / AW<br><br>14. **I** low risk experiment **R** no risk<br>**A** *idea of* excluding / being aware of, people with, caffeine or coffee or drink allergy / epilepsy (brought on by flashing lights) / heart conditions / neurological conditions / pregnancy / asthma<br>**I** allergy / diabetes unqualified |
| 1(c)(i) | (both sets of) data are continuous / data (are approximately) normally distribution / scatter graph or data or it suggests or shows a linear correlation / 5 or more paired observations **;** | **1** | **A** interval data **A** relationship for correlation<br>**I** trend / pattern |
| 1(c)(ii) | there is a negative (linear) correlation / as caffeine concentration increases as reaction time decreases **;** | **1** | **A** relationship for correlation **I** trend / pattern<br>**I** qualification, e.g. strong / weak |

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| 1(c)(iii) | subtract 2 from the (total) number of pairs of data **;** | **1** | **I** number alone<br>*df* = n – 2 / 10 – 2 (= 8)<br>**A** n – 1 / 10 – 1 (= 9)<br>**or**<br>n = 10<br>**or**<br>(n – 1) + (n – 1) / 10 – 1 + 10 – 1 (= 18)<br>**A** categories / samples for pairs of data<br>**I** subjects |
| 1(c)(iv) | 1. use the probability table at 5% / 0.05 **;**<br><br>2. compare the (calculated) ***r*** value / 0.722, to the critical value / 0.632 **;**<br><br>3. significant, if / as, (calculated) ***r*** value / 0.722, is **higher** than critical value / **ora ;** | **3** | <br><br>2. **A** table / tabulated, values as AW for critical values<br>**A** *ref. to* higher / lower as evidence of comparison<br><br>3. **A** (less than) 5% probability / P = (<) 0.05, that the value is due to chance<br>**A** 95% chance, that it is significant / that it is not due to chance<br>**A** 'reject the null hypothesis'<br>**I** *ref. to* the sign + or –<br>**R** if *ref. to* 'expected v observed' / significant difference |
| 1(d) | 1. *idea that* only one person was tested for each of the concentrations **;**<br><br>2*. idea that* a response could be, atypical / anomalous<br>**or**<br>people vary in their response (to caffeine) / an example of a possible variation in response **;** | **2** | 1. **A** only 10 subjects<br>**I** not a large number of / not enough, subjects / AW<br><br>2. **A** *ref.to* subject 5 or 6 is anomalous<br>**I** *ref. to* other experimental conditions not being controlled. |
| 1(e) | *idea that* concentration of acetylcholine remains high (in synapses)<br>**so**<br>*idea that* reaction time is faster / (muscles) respond more quickly / response is more rapid / (post synaptic) neurones (supplying muscle) continue to be stimulated **;** | **1** | **A** more acetylcholine present / acetylcholine, remains for longer / not broken down / increases / constantly secreted, **so**…..<br><br>**I** reduces time for impulse to travel / impulse (s) travel faster / more synapses / AW |

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| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 2(a)(i) | *max 2 of:*<br>1. the number of times the populations were sampled **;**<br><br>2. the number of locations within each site **;**<br><br>3. the time of year that the populations were sampled **;**<br><br>4. the day on which samples were taken (was the same) **;**<br><br>5. *idea that* (size always) measured, as length / to nearest mm / in mm **;**<br><br>6. (one / the same) species of beetle (counted) **;** | **2** | 1. populations sampled, 10 / the same number of, times<br><br>3. **A** populations sampled in the, same / warmest, (3) months / time of year / season **I** temperature |
| 2(a)(ii) | 1. trap / collect / sample / capture / AW, beetles, mark **and** release **;**<br><br>2. re-trap beetles, and count / record the number of marked beetles, out of the total number recaptured **;** | **2** | *max 1 for* 'mark, release, recapture' unqualified<br>*2 marks for* mark, release, recapture **and correct** formula<br>**I** incorrect / incomplete formula<br>correct formula = $\frac{\text{number in first sample} \times \text{number in second sample}}{\text{marked number in second sample}}$ |

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>2(b)(i)</td><td>
<table>
<tr><td>site</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>population of beetles</td><td>10 792</td><td>11 314</td><td>18 426</td><td>15 224</td><td>17 650</td></tr>
<tr><td>number of large beetles</td><td>6520</td><td>6276</td><td>10 687</td><td>6432</td><td>6523</td></tr>
<tr><td>number of small beetles</td><td>4272</td><td>5038</td><td><u>7739</u> ;</td><td>8792</td><td>11 127</td></tr>
<tr><td>percentage of large beetles</td><td>60</td><td><u>55</u> ;</td><td>58</td><td>42</td><td>37</td></tr>
</table>
</td><td>2</td><td></td></tr>
<tr><td>2(b)(ii)</td><td>supports<br>idea that as the, percentage / proportion, of large beetles is, less in higher temperatures / more in lower temperatures ;</td><td>1</td><td>A E hottest and has smallest, percentage / proportion of large beetles<br>I any ref. to population size / number<br>A partially or not supported if justified, e.g. idea that no clear pattern throughout range / ABC (BC / AB / AC) percentages similar but temperature varies<br>A idea that no data relating to actual body size</td></tr>
</table>

| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 2(c) | *max 2 of:*<br>1. as temperature increases, proportion / percentage of, large beetles decreases **;** **ora**<br><br>2. *idea that* (temperature) variations between **A**, **B** and **C** do not seem to affect size much as, percentage / proportion, of large beetles similar (60, 55, 58) **;**<br><br>3. *ref. to* differences in annual (temperature) range related to, percentage / proportion of, large / small, beetles **;**<br><br>4. *ref. to* average **yearly** temperature values or groups of values linked correctly to stated percentage or proportion of, large / small, beetles **;**<br><br>5. *ref. to* **lowest** average temperature values or groups of values linked correctly to stated percentage or proportion of, large / small, beetles **;**<br><br>6. *ref. to* **highest** average temperature values or groups of values linked correctly to stated percentage or proportion of, large / small, beetles **;** | **2** | ***I*** *population size / number*<br>1. **A** size as equating to proportion or percentage, e.g. body size decreases as temperature increases for **ora** |
| 2(d) | *must state what the aspect of climate change is considered*<br>*e.g. warmer / cooler / more extreme / wetter / drier / windier / stormier, etc*<br><br>**one** example of at least one possible climatic change **and** effect on population number **or** beetle size **;** | **1** | *the effect must be possible in relation to the aspect of climate change quoted but does not need to be justified*<br>*e.g.*<br>**A** if global temperature rises / falls, would expect, smaller / larger / AW, populations<br>**A** if global temperature rises would expect a higher, percentage / proportion, of small beetles in the population **ora**<br>**A** global warming may result in an overall smaller body size<br>**A** global warming could increase predators so reducing beetles |

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| **ora** | or reverse argument |
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| **I** | ignore |
| **mp** | marking point (with relevant number) |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(a) | *independent variable:* concentration of caffeine **;**<br>*dependent variable:* number of (heart) beats per unit time / heart rate **;** | **2** | |
| 1(b)(i) | use two tablets **;**<br><br>add 1 $dm^3$ or 1000 ml / $cm^3$ or 1 litre (distilled) water **;** | **2** | **A** any correct proportions of water and tablets whatever the total volume, e.g. one tablet in 500 $cm^3$ / 0.5 $dm^3$ water |
| 1(b)(ii) | to keep it in one position / to stop it from moving / swimming (to make it easier to count the heart beat) **;** | **1** | |
| 1(b)(iii) | *max 6 of:*<br>1 *ref. to* a **method** of diluting 100 mg $dm^{-3}$ caffeine solution, e.g. proportional / simple / serial dilution or a description **and** minimum of 4 additional dilutions **;**<br><br>2 *ref. to* concentrations from 100 mg $dm^{-3}$ downwards with correct units **;**<br>*values stated must correspond to the dilution method chosen*<br><br>3 use of water / 0 mg $dm^{-3}$ as a control **;**<br><br>4 allow *Daphnia* to acclimatise **after** adding caffeine / to absorb the caffeine **;**<br><br>5 *ref. to* method of counting number of heart beats, e.g. clicker counter / tally counter / record dots on paper and count / video **;**<br><br>6 use of same period of time (for counting **;**<br><br>7 same volume / same number of drops of caffeine solution added to each slide **;** *if a value stated must be max 1 $cm^3$ or 5 drops* | **6** | *proportional / simple:* (100), 80, 60, 40, 20, (0) mg $dm^{-3}$<br>*serial:* (100), 50, 25, 12.5, 6.25 / (100), 10, 1, 0.1, 0.01 mg $dm^{-3}$<br>*must have a minimum of 3 others between 0.0 and 100.0 mg $dm^{-3}$*<br><br>*standardising variables (mp6–mp8) – must be clear that all the concentrations have been tested* ***or*** *one concentration has been tested more than once on Daphnia* |

<table>
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<tr><td></td><td>8 use the same organism / same size / same length / same age / same species / same type Daphnia for all caffeine concentrations ;<br><br>9 ref. to a minimum of three replicates and calculate a <u>mean</u> or identify / eliminate / remove / ignore anomalies or outliers ;<br><br>10 description of ethical treatment of live Daphnia AW, e.g. careful handling (when being moved) to minimise damage / return to tank promptly after testing / minimum time in caffeine solution ;<br><br>11 low risk experiment / suitable hazard and safety precaution, e.g. allergy to caffeine and gloves ;</td><td></td><td></td></tr>
<tr><td>1(b)(iv)</td><td>source of error is max 1 and must be clearly stated<br>improvement is max 1 and must match the source of error<br><br>
<table>
<tr><th>error</th><th>improvement</th></tr>
<tr><td>heat from light in microscope ;</td><td>turn lamp on only when needed / heat shield ;</td></tr>
<tr><td>evaporation of water from slide ;</td><td>use a cover slip / top up with same solution ;</td></tr>
<tr><td>animals are stressed ;</td><td>handle only when needed / minimise time in experimental conditions ;</td></tr>
<tr><td>cumulative effect of caffeine (on one Daphnia) ;</td><td>allow recovery time / use different Daphnia ;</td></tr>
<tr><td>difficulty in counting ;</td><td>any suitable improvement, e.g. video and slow down ;</td></tr>
<tr><td>no time allowed for caffeine absorption ;</td><td>have a time delay before counting ;</td></tr>
<tr><td>drop size varies ;</td><td>use a known volume of caffeine solution ;</td></tr>
</table></td><td>2</td><td>A any other valid source of error and a suitable improvement<br>I ref. to magnification used</td></tr>
</table>

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(c) | *Daphnia* belong to a different phylum / data collected was not from humans **;** | **1** | **A** any *ref. to* differences in heart structure of humans and *Daphnia* |
| 1(d)(i) | (2.4 mg 100 $cm^{-3}$ cola, trial 3) <u>228</u> **;** | **1** | |
| 1(d)(ii) | *max 2 of:*<br>range of concentration too narrow **;**<br><br>no data for caffeine at 0.0 / below 2.4 / above 6.0 mg $cm^{-3}$ **;**<br><br>not enough concentration / only 4 concentrations **;**<br><br>there is overlap between some of data collected for 4.8 and 6.0 mg $cm^{-3}$ **;**<br><br>*idea that* proportional increases in concentration should give a proportional increase in heart rate **;** | **2** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2(a) | there is no significant correlation / relationship / association between the percentage / proportion of cyanogenic *T. repens* and (increasing mean January) temperature **;** | **1** | |
| 2(b)(i) | column **3** completed correctly **;**<br><br>column **6** completed correctly **;** | **2** | **ecf** for column 6 from errors in column 3 |

| 1 | 2 | **3** | 4 | 5 | **6** | 7 |
|---|---|---|---|---|---|---|
| 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 | **8** | 12.2 | 8 | **0** | 0 |
| Fairbanks | 5 | **2** | –23.9 | 1 | **1** | 1 |
| Karaj River | 64 | **5** | 4.4 | 6 | **-1** | 1 |
| Konosu | 50 | **4** | 4.2 | 5 | **-1** | 1 |
| Lennoxville | 71 | **7** | –10.0 | 4 | **3** | 9 |
| Mandan | 33 | **3** | –12.8 | 3 | **0** | 0 |
| Novosibirsk | 0 | **1** | –19.4 | 2 | **–1** | 1 |
| Pretoria | 68 | **6** | 10.0 | 7 | **–1** | 1 |
| Rabat | 100 | **9 ;** | 12.5 | 9 | **0 ;** | 0 |
| | | | | | **$\Sigma D^2$ =** | 14 |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2(b)(ii) | $r_s - 1 - \frac{(6 \times 14)}{(\mathbf{9^3 - 9})}$ **;**<br><br>$r_s - 1 - \frac{(84)}{(720)}$<br><br>$r_s$ = <u>0.88</u> **;** | **2** | *max 1 if correct answer is given to more than 2 d.p.* |
| 2(b)(iii) | calculated value / <u>0.88</u>, is greater than, the critical value / <u>0.68</u><br>**or**<br>critical value / <u>0.68</u>, is less than, the calculated value / <u>0.88</u> **;** | **1** | **ecf** from incorrect answer in 2(b)(ii) |
| 2(b)(iv) | *max 1 of:*<br>*idea that* cyanogenic plants **grow** better at higher temperature **;**<br><br>*idea that* cyanogenic plants more able to survive grazing (by herbivores) **;**<br><br>*idea that* cyanogenic plants produce **more** hydrogen cyanide which, **reduces** grazing / kills (more), herbivores **;** | **1** | *must be comparative* |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3(a) | *max 3 of:*<br>same location / area used **;**<br><br>same time of year / same two weeks in August **;**<br><br>traps were equally spaced (along the transect) **;**<br><br>along same transects / transects were at the same places **;**<br><br>numbers calculated per 1000 traps / same number of traps were used **;** | **3** | **I** species of vole |
| 3(b) | 1 $q^2 = 0.16$ **or** $\frac{8}{50}$ **or** $\frac{4}{25}$ **or** 16%<br>**OR** $q = 0.4$ **or** $\frac{2}{5}$ **or** 4% **;**<br>2 derives *2pq* correctly from a clearly stated value of *p* **and** a clearly stated value of *q* **;**<br><br>3 in 1997 heterozygous voles = $(0.48 \times 60) = 29$ voles **;** | **3** | *max 2 if answer not rounded **or** p is incorrect*<br>***A** answers in equation as percentages*<br><br>2 **ecf** if *q* is incorrect (e.g. $q = 0.16$) but then correctly used to get *2pq*<br><br>3 **ecf** (any number) $\times$ 60 (from graph) **and** a whole number rounded correctly |

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| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 1(a) | *idea that,* results / they / it / test, could be affected by subject expectation / AW **;** | **1** | **A** 'results' in terms of, heart beat / heart rate / pulse rate / reaction time AW<br>**I** may affect results / fair test / *ref. to* reliable results unqualified |
| 1(b)(i) | *independent variable*<br>presence (or absence) of caffeine **;**<br><br>*dependent variables*<br>heart rate **and,** reaction / response, time **;** | **2** | **A** caffeine concentration / volume of caffeine<br>**A** pulse rate / number of (heart) beats per minute<br>**A** description of reaction time, e.g. time to press switch |
| 1(b)(ii) | *max 8 of:*<br>1. *ref. to* having a large number of test subjects / AW **;**<br><br>2. *ref. to* subjects / groups, have drinks with **and** without caffeine **;**<br><br>3. *ref. to* description of method of making drinks indistinguishable<br>**or**<br>*ref. to* method that only, experimenter / student, can tell which is which **;**<br><br>*procedure*<br>4. *ref. to* test-subjects not, drinking / taking in, any caffeine (drink) for at least 5 hours before the test **;**<br><br>5. *Idea that e*ach subject being tested in isolation / away from others (throughout the experiment) **;**<br><br>6. *ref. to* subject, at rest / quiet, during test / after test / whilst having measurements (reaction time **and** heart rate) taken **;**<br><br>7. *ref. to* taking measurements (of reaction time **and** heart rate) **before** giving the drink **;** | **8** | 1. if number stated, minimum of 10 with caffeine<br><br>2. **A** water / 0 mg caffeine / AW as decaffeinated drink |

| Question | Answer | Mark | Guidance |
|---|---|---|---|
| | 8. *ref. to* waiting (a minimum of) 45 minutes **after** giving the drink before measuring (the reaction time **and** heart rate) **;**<br><br>9. *ref. to* giving the same volume of drink (to all subjects) **;**<br><br>10. *ref. to* test subjects being, all caffeine / all non-caffeine, users **;**<br><br>11. *ref. to* test subjects being, same / similar, age / mass / weight / fitness level / ethnicity / race **;**<br><br>12. *idea of* standardised sex balance **;**<br><br>13. calculate mean (for the measurements) **;**<br><br>14. *ref. to idea that* health questionnaire / getting permission before testing / being aware of potential health risks<br>**or**<br>*ref. to* allowing test-subjects to stop if they feel unwell **;** | | 8. **A** other stated times **up to** 2 hours / 120 minutes<br>**R** around / about 45 minutes<br><br>9. **A** stated volumes, e.g. 100 – 350 $cm^3$ **A** 'a can' / 'a bottle' / 'a cup'<br><br>10: **I** *ref to*. paired sampling<br><br>11. **A** same age range (e.g. 35–40) **I** *ref. to* health here (see mp 14)<br><br>12. **A** have all of one sex / equal numbers of one sex<br><br>13. **I** average **A** repeat three times and take a mean / AW<br><br>14. **I** low risk experiment **R** no risk<br>**A** *idea of* excluding / being aware of, people with, caffeine or coffee or drink allergy / epilepsy (brought on by flashing lights) / heart conditions / neurological conditions / pregnancy / asthma<br>**I** allergy / diabetes unqualified |
| 1(c)(i) | (both sets of) data are continuous / data (are approximately) normally distribution / scatter graph or data or it suggests or shows a linear correlation / 5 or more paired observations **;** | **1** | **A** interval data **A** relationship for correlation<br>**I** trend / pattern |
| 1(c)(ii) | there is a negative (linear) correlation / as caffeine concentration increases as reaction time decreases **;** | **1** | **A** relationship for correlation **I** trend / pattern<br>**I** qualification, e.g. strong / weak |

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| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 1(c)(iii) | subtract 2 from the (total) number of pairs of data **;** | **1** | **I** number alone<br>*df* = n – 2 / 10 – 2 (= 8)<br>**A** n – 1 / 10 – 1 (= 9)<br>**or**<br>n = 10<br>**or**<br>(n – 1) + (n – 1) / 10 – 1 + 10 – 1 (= 18)<br>**A** categories / samples for pairs of data<br>**I** subjects |
| 1(c)(iv) | 1. use the probability table at 5% / 0.05 **;**<br><br>2. compare the (calculated) ***r*** value / 0.722, to the critical value / 0.632 **;**<br><br>3. significant, if / as, (calculated) ***r*** value / 0.722, is **higher** than critical value / **ora ;** | **3** | <br><br>2. **A** table / tabulated, values as AW for critical values<br>**A** *ref. to* higher / lower as evidence of comparison<br><br>3. **A** (less than) 5% probability / P = (<) 0.05, that the value is due to chance<br>**A** 95% chance, that it is significant / that it is not due to chance<br>**A** 'reject the null hypothesis'<br>**I** *ref. to* the sign + or –<br>**R** if *ref. to* 'expected v observed' / significant difference |
| 1(d) | 1. *idea that* only one person was tested for each of the concentrations **;**<br><br>2*. idea that* a response could be, atypical / anomalous<br>**or**<br>people vary in their response (to caffeine) / an example of a possible variation in response **;** | **2** | 1. **A** only 10 subjects<br>**I** not a large number of / not enough, subjects / AW<br><br>2. **A** *ref.to* subject 5 or 6 is anomalous<br>**I** *ref. to* other experimental conditions not being controlled. |
| 1(e) | *idea that* concentration of acetylcholine remains high (in synapses)<br>**so**<br>*idea that* reaction time is faster / (muscles) respond more quickly / response is more rapid / (post synaptic) neurones (supplying muscle) continue to be stimulated **;** | **1** | **A** more acetylcholine present / acetylcholine, remains for longer / not broken down / increases / constantly secreted, **so**…..<br><br>**I** reduces time for impulse to travel / impulse (s) travel faster / more synapses / AW |

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| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 2(a)(i) | *max 2 of:*<br>1. the number of times the populations were sampled **;**<br><br>2. the number of locations within each site **;**<br><br>3. the time of year that the populations were sampled **;**<br><br>4. the day on which samples were taken (was the same) **;**<br><br>5. *idea that* (size always) measured, as length / to nearest mm / in mm **;**<br><br>6. (one / the same) species of beetle (counted) **;** | **2** | 1. populations sampled, 10 / the same number of, times<br><br>3. **A** populations sampled in the, same / warmest, (3) months / time of year / season **I** temperature |
| 2(a)(ii) | 1. trap / collect / sample / capture / AW, beetles, mark **and** release **;**<br><br>2. re-trap beetles, and count / record the number of marked beetles, out of the total number recaptured **;** | **2** | *max 1 for* 'mark, release, recapture' unqualified<br>*2 marks for* mark, release, recapture **and correct** formula<br>**I** incorrect / incomplete formula<br>correct formula = $\frac{\text{number in first sample} \times \text{number in second sample}}{\text{marked number in second sample}}$ |

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>2(b)(i)</td><td>
<table>
<tr><td>site</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>population of beetles</td><td>10 792</td><td>11 314</td><td>18 426</td><td>15 224</td><td>17 650</td></tr>
<tr><td>number of large beetles</td><td>6520</td><td>6276</td><td>10 687</td><td>6432</td><td>6523</td></tr>
<tr><td>number of small beetles</td><td>4272</td><td>5038</td><td><u>7739</u> ;</td><td>8792</td><td>11 127</td></tr>
<tr><td>percentage of large beetles</td><td>60</td><td><u>55</u> ;</td><td>58</td><td>42</td><td>37</td></tr>
</table>
</td><td>2</td><td></td></tr>
<tr><td>2(b)(ii)</td><td>supports<br>idea that as the, percentage / proportion, of large beetles is, less in higher temperatures / more in lower temperatures ;</td><td>1</td><td>A E hottest and has smallest, percentage / proportion of large beetles<br>I any ref. to population size / number<br>A partially or not supported if justified, e.g. idea that no clear pattern throughout range / ABC (BC / AB / AC) percentages similar but temperature varies<br>A idea that no data relating to actual body size</td></tr>
</table>

| Question | Answer | Mark | Guidance |
|---|---|---|---|
| 2(c) | *max 2 of:*<br>1. as temperature increases, proportion / percentage of, large beetles decreases **;** **ora**<br><br>2. *idea that* (temperature) variations between **A**, **B** and **C** do not seem to affect size much as, percentage / proportion, of large beetles similar (60, 55, 58) **;**<br><br>3. *ref. to* differences in annual (temperature) range related to, percentage / proportion of, large / small, beetles **;**<br><br>4. *ref. to* average **yearly** temperature values or groups of values linked correctly to stated percentage or proportion of, large / small, beetles **;**<br><br>5. *ref. to* **lowest** average temperature values or groups of values linked correctly to stated percentage or proportion of, large / small, beetles **;**<br><br>6. *ref. to* **highest** average temperature values or groups of values linked correctly to stated percentage or proportion of, large / small, beetles **;** | **2** | ***I** population size / number*<br>1. **A** size as equating to proportion or percentage, e.g. body size decreases as temperature increases for **ora** |
| 2(d) | *must state what the aspect of climate change is considered*<br>*e.g. warmer / cooler / more extreme / wetter / drier / windier / stormier, etc*<br><br>**one** example of at least one possible climatic change **and** effect on population number **or** beetle size **;** | **1** | *the effect must be possible in relation to the aspect of climate change quoted but does not need to be justified*<br>*e.g.*<br>**A** if global temperature rises / falls, would expect, smaller / larger / AW, populations<br>**A** if global temperature rises would expect a higher, percentage / proportion, of small beetles in the population **ora**<br>**A** global warming may result in an overall smaller body size<br>**A** global warming could increase predators so reducing beetles |