OCR
Oxford Cambridge and RSA

# GCE

# Further Mathematics B MEI

## Y422/01: Statistics major

A Level

# Mark Scheme for June 2022

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

© OCR 2022

## Text Instructions

### 1. Annotations and abbreviations

| Annotation in scoris | Meaning |
|---|---|
| ✓and ✗ | |
| BOD | Benefit of doubt |
| FT | Follow through |
| ISW | Ignore subsequent working |
| M0, M1 | Method mark awarded 0, 1 |
| A0, A1 | Accuracy mark awarded 0, 1 |
| B0, B1 | Independent mark awarded 0, 1 |
| E | Explanation mark 1 |
| SC | Special case |
| ^ | Omission sign |
| MR | Misread |
| BP | Blank page |
| Highlighting | |
| | |
| **Other abbreviations in mark scheme** | **Meaning** |
| E1 | Mark for explaining a result or establishing a given result |
| dep* | Mark dependent on a previous mark, indicated by *. The * may be omitted if only previous M mark. |
| cao | Correct answer only |
| oe | Or equivalent |
| rot | Rounded or truncated |
| soi | Seen or implied |
| www | Without wrong working |
| AG | Answer given |
| awrt | Anything which rounds to |
| BC | By Calculator |
| DR | This indicates that the instruction **In this question you must show detailed reasoning** appears in the question. |

## 2. Subject-specific Marking Instructions for AS Level Mathematics B (MEI)

a Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award NR (No Response)

- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark, a picture) which isn't an attempt at the question.

Note: Award 0 marks only for an attempt that earns no credit (including copying out the question).

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

c The following types of marks are available.

**M**
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.
A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words "Determine" or "Show that", or some other indication that the method must be given explicitly.

**A**
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

**B**
Mark for a correct result or statement independent of Method marks.

**E**
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case, please escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)
We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.

- When a value is **given** in the paper only accept an answer correct to at least as many significant figures as the given value.
- When a value is **not given** in the paper accept any answer that agrees with the correct value to **2 s.f.** unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.
  NB for Specification A the rubric specifies 3 s.f. as standard, so this statement reads "3 s.f"

Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.
Candidates using a value of 9.80, 9.81 or 10 for *g* should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

g Rules for replaced work and multiple attempts:

- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors. If a candidate corrects the misread in a later part, do not continue to follow through. E marks are lost unless, by chance, the given results are established by equivalent working. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" and "Determine. Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 1 | (a) | | P(2 meteors) = 0.2169 | B1 [1] | 1.1 | |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 1 | (b) | | P(> 3 meteors) = 1 – 0.9662<br>= 0.0338 | M1<br>A1<br>[2] | 1.1<br>1.1 | Or [P(> 3 meteors) =] 1 – P(≤ 3 meteors)<br>BC |
| 1 | (c) | | Mean = 10 × 1.2 = 12<br>P(≤ 8 meteors) = 0.1550 | B1<br>B1<br>[2] | 3.3<br>1.1 | <br>BC |
| 1 | (d) | | Meteors occur randomly, independently<br>and at a uniform average rate | E1<br>E1<br>[2] | 2.2b<br>2.4 | Allow 'constant average rate' and 'same average rate'<br>No context needed due to question giving context<br>Needs to have 'constant' oe and 'average' oe Not 'overall' |
| 2 | (a) | | Five A ~ N(5 × 23, 5 × $2.8^2$)<br>N(115, 39.2)<br>P(≥ 120) = 0.212 (0.212262…) | B1<br>M1<br>A1<br>[3] | 3.3<br>1.1<br>3.4 | For N and mean<br>For variance<br>BC |
| 2 | (b) | | Three A – two B~ N(3×23 – 2×35, 3×$2.8^2$ + 2×$3.6^2$)<br>N(–1, 49.44)<br>P(3 A last longer) = 0.443 (0.443453 …) | B1<br>M1<br>A1<br>[3] | 3.3<br>1.1<br>3.4 | For N and mean Allow mean = +1<br>For variance<br>BC |
| 2 | (c) | | Because adding variances only gives the correct combined variance if the variables are independent. | E1<br>[1] | 2.3 | Ignore comments about Expectation |
| 3 | (a) | | $b + 0.48 + 0.96 + 4b^2 = 1.8$<br>$b = 0.2$<br>$a + b + b^2 + 0.24 + 0.32 = 1 \Rightarrow a = 0.2$ | M1<br>A1<br>B1<br>[3] | 3.1a<br>1.1<br>1.1 | <br>BC<br>FT $0.44 - b - b^2$ |
| 3 | (b) | | E($Y$) = 10 – 3 × 1.8 = 4.6<br>Var($X$) = 1.44<br>Var($Y$) = 9 × 1.44 = 12.96 | B1<br>B1<br>B1<br>[3] | 1.1<br>3.1a<br>1.1 | <br>BC Can get B1 implied by correct answer to Var($Y$)<br>FT their Var ($X$) |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 4 | (a) | | $P(X \geq 10) = \frac{k-9}{k}$ or $1 - \frac{9}{k}$ | M1<br>A1<br>[2] | 3.1a<br>1.1 | Allow M1 for numerator $k - 10$ or answer $1 - \frac{10}{k}$ |
| 4 | (b) | | Probability of 1 card being less than 9 = 0.4<br>$0.4^2 + 2 \times 0.4^2 \times 0.6 + 3 \times 0.4^2 \times 0.6^2$<br><br>= 0.5248 or $\frac{328}{625}$ | B1<br>M1<br><br>A1<br>[3] | 3.1a<br>1.1<br><br>1.1 | For 0.4 or 0.6 seen<br>Allow with their 0.4 and 0.6. Allow one coefficient incorrect.<br>OR using $X \sim B(4, 0.6)$ OR using $X \sim B(4, 0.4)$<br>$P(X \leq 2) = 0.5248$ $1 - P(X \leq 1) = 0.5248$ |
| 5 | (a) | | $P = 0.01145t + 1.786$ | M1<br>A1<br>[2] | 3.3<br>1.1 | For either 0.01145 or 1.786 (1.7858444)<br>BC Allow 3sf |
| 5 | (b) | | Residual for 28 = 2.114 – (0.01145 × 28 + 1.786)<br>or Residual for 36 = 2.192 – (0.01145 × 36 + 1.786)<br>Residual for 28 = 0.007<br>Residual for 36 = –0.006 | M1<br><br>A1<br>A1<br>[3] | 1.1a<br><br>1.1<br>1.1 | Allow if wrong way around<br><br>Allow 0.006 to 0.008 Allow without referring to part (a)<br>Allow −0.007 to −0.005 |
| 5 | (c) | | The fit is good as the residuals are all fairly small<br><br>and there is no discernible pattern to suggest that the fit is non-linear | E1<br><br>E1<br>[2] | 2.2a<br><br>1.1 | Must be with reference to residuals<br>Do not allow 'Sum of residuals is small'<br>Allow 'residuals not in blocks' |
| 5 | (d) | | Temperature 25°C Pressure ≈ 2.07(2)<br>Temperature 10°C Pressure ≈ 1.90(0) | B1<br><br>B1<br>[2] | 1.1<br>1.1 | FT awrt 2.07<br>FT awrt 1.90<br>If both given to 1dp allow MAX B0B1. If either given to **more** than 3dp allow MAX B0B1 |
| 5 | (e) | | Because the residuals are small, (and it is interpolation), the first prediction likely to be reliable.<br>The second prediction is rather less reliable because it is extrapolation. | E1<br><br>E1<br>[2] | 2.2a<br><br>3.5b | Allow 'As points lie close to the line'<br><br>If only mention interpolation/extrapolation MAX E1E0 |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 6 | (a) | | **DR**<br>Est of pop variance = $\dfrac{6050.3-\dfrac{491.84^2}{40}}{39}$<br>$=\dfrac{2.63536}{39}=0.06757$<br>Confidence interval is<br>12.296<br>$\pm$ 1.96<br>$\times\sqrt{\dfrac{0.06757}{40}}$ or $\times\dfrac{0.25994}{\sqrt{40}}$<br>= 12.296 $\pm$ 0.081 or (12.215, 12.377)<br>Allow 12.296 $\pm$ 0.080 or (12.216, 12.376) | **M1**<br>**A1**<br>**B1**<br>**M1**<br>**M1**<br>**A1**<br>**[6]** | **1.1**<br>**1.1**<br>**1.1**<br>**3.3**<br>**1.1**<br>**3.4** | Accept denominator of 40 rather than 39 for M1<br>Allow 0.676 Or sd = 0.25994<br>or $\frac{491.84}{40}$ seen anywhere<br>Accept *t*-value of 2.02<br>Accept based on *t*-distribution (12.213, 12.379)<br>Allow 12.22 to 12.38 |
| 6 | (b) | | It does support the belief because the confidence interval does not contain 12.2 | **E1**<br>**[1]** | **3.5a** | Must be unassertive EG do not allow 'the researcher is correct'<br>FT their interval |
| 6 | (c) | | A random sample enables proper inference about the population to be undertaken | **E1**<br>**[1]** | **2.4** | Do NOT allow 'so that the distribution can be modelled by a Normal…' oe |
| 6 | (d) | | Sample mean = 1.3<br>$0.098=1.96\times\sqrt{\dfrac{0.25}{n}}$<br>Sample size = 100 | **B1**<br>**M1**<br>**A1**<br>**[3]** | **1.1**<br>**3.1b**<br>**1.1** | Do not allow M1 for 0.25 rather than $\sqrt{0.25}$ |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 7 | (a) | | $P(X = 5) = 0.7^4 \times 0.3$<br>$=0.07203$ | **M1**<br>**A1**<br>**[2]** | **3.3**<br>**1.1** | <br>Allow 0.072 |
| 7 | (b) | | $P(X > 3) = 0.7^3 = 0.343$<br>Use of binomial (6, their 0.343)<br>P(At least 4 out of 6) = 1 – 0.8900 = 0.1100 | **B1**<br>**M1**<br>**A1**<br>**[3]** | **1.1**<br>**3.3**<br>**1.1** | <br>With their 0.343 but not 0.3 or 0.7. Must be stated if not 0.343<br>Allow 0.110 |
| 7 | (c) | | $(1-p)p = \frac{28}{121}$<br>$\Rightarrow 121p^2 - 121p + 28 = 0$<br>$p = \frac{4}{11}$ or $p = \frac{7}{11}$ | **M1**<br>**M1**<br>**A1**<br>**[3]** | **3.1a**<br>**2.1**<br>**1.1** | <br>Allow sign errors<br>BC Allow 0.363… and 0.636… |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 8 | (a) | | The other student is incorrect since both variables are random<br>so it is equally correct to plot the variables either way around. | **E1**<br>**E1**<br>**[2]** | **2.2a**<br>**2.4** | Condone 'one variable does not affect the other' or 'both variables are independent'<br>Dependent on first mark |
| 8 | (b) | | Because the scatter diagram does not appear to be elliptical due to the outliers so the distribution is probably not bivariate Normal. | **E1**<br>**E1**<br>**[2]** | **3.5a**<br>**2.4** | For elliptical<br>For full answer (dependent on first mark)<br>Condone 2 clusters instead of outliers |
| 8 | (c) | | **DR**<br>Rank B: 1 2 3 4 5 6 7 8 9 10 11<br>Rank F: 1 6 2 8 5 7 9 4 3 10 11 | **M1**<br>**M1** | **1.1**<br>**1.1** | For ranking Butterfly<br>For ranking Freestyle Allow M1M1 for $\sum d^2 = 90$<br>may see $1 - \frac{6\times90}{11\times(121-1)}$ |
| | | | Spearman's rank coefficient = 0.5909 | **A1** | **1.1** | BC Allow 0.59 |
| | | | $H_0$: There is no association between Butterfly and Freestyle times in the population | **B1** | **3.3** | For both. Do not allow correlation |
| | | | $H_1$: There is some association between Butterfly and Freestyle times in the population | **B1** | **1.2** | Need to see population in one or other of the hypotheses for second B1 |
| | | | For $n$ = 11, 5% critical value is 0.6182 | **B1** | **3.4** | |
| | | | 0.5909 < 0.6182 | **M1** | **1.1** | For comparison provided $\lvert r_s\rvert < 1$ (provided sensibly obtained) and sensible critical value eg 0.6021 |
| | | | Do not reject $H_0$. There is insufficient evidence to suggest that there is association between Butterfly and Freestyle times [in the population] | **A1**<br>**[8]** | **2.2b** | Do not FT their $r_s$ Must be in context. Do not allow correlation<br>No marks for PMCC test |
| 8 | (d) | | If the test had been done at a different level, the conclusion may have been different<br>Or A 5% significance level means that you will come to the wrong conclusion 5% of the time. | **E2**<br>**[2]** | **2.2b**<br>**2.4** | Oe EG 'With a different sample the results might be different'<br>Allow **E1** for 'The conclusion of a hypothesis test is never certain' |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 9 | (a) | | $P(X \leq 7) = \frac{8}{21}$ | B1 [1] | 1.1 | Allow 0.381 |
| 9 | (b) | | $E(X) = 10$ | B1 | 1.1 | |
| | | | $Var(X) = \frac{1}{12}(21^2 - 1)$ | M1 | 1.2 | Allow M1 for $Var(X) = \frac{1}{12}(20^2 - 1)$ |
| | | | $= \frac{110}{3}$ | A1 [3] | 1.1 | Or 36.7 or better |
| 9 | (c) | | $P(Y \leq 7) = \frac{4}{25}$ | B1 [1] | 1.1 | |
| 9 | (d) | | Because $Var(Y) = \frac{Var(X)}{10}$ | B1 | 2.2a | Allow $Var(Y) < Var(X)$ If they get $Var(Y) = Var(X)/100$ or other error then B0 even if then say $Var(Y) < Var(X)$ |
| | | | and so values of $Y$ are more likely to be closer to the mean than values of $X$. ($E(X)$ and $E(Y)$ are both 10) | B1 [2] | 2.4 | oe |
| 9 | (e) | | $Var(W) = \frac{11}{9}$ | B1 | 1.1 | Allow their $\frac{Var(X)}{30}$ |
| | | | By CLT distribution is approx $N\left(10, \frac{11}{9}\right)$ | M1 | 2.2a | Using their mean from (b) and their var($W$) |
| | | | $P(W \leq 7)$ with CC is $P\left(Z \leq 7\frac{1}{60}\right)$ | B1 | 3.4 | For CC (Continuity correction) |
| | | | 0.00348 | A1 [4] | 1.1 | Allow 3 marks for 0.00333 (0.0033278…) (No CC) Allow 0.0035 Allow equivalent method eg using total rather than mean |

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 10 | (a) | | Low-normal $= \frac{32\times12}{60} = 6.4$, Low-high $= \frac{28\times12}{60} = 5.6$<br>Medium-normal $= \frac{32\times31}{60} = 16.5333$<br>Medium-high $= \frac{28\times31}{60} = 14.4667$ | **B1**<br><br><br>**B1**<br>**[2]** | **3.4**<br><br><br>**1.1** | B1 for any one correct<br><br><br>B1 for the other 3 (by subtraction) |
| 10 | (b) | | $\frac{(5-9.0667)^2}{9.0667}$<br>= 1.8240 | **M1**<br>**A1**<br>**[2]** | **1.1**<br>**1.1** | For $\frac{(O-E)^2}{E}$ |
| 10 | (c) | | **DR**<br>$H_0$: no association between dietary fat intake and cholesterol level<br>$H_1$: some association between dietary fat intake and cholesterol level<br>Test statistic = 6.4508<br>Degrees of freedom = 2<br>Critical value = 5.991<br>6.4508 > 5.991 so reject $H_0$<br>There is sufficient evidence to suggest that there is some association between dietary fat intake and cholesterol level. | <br><br>**B1**<br>**B1**<br>**B1**<br>**M1**<br>**A1**<br>**[6]** | <br><br>**2.5**<br>**1.1**<br>**3.3**<br>**1.1**<br>**2.2b**<br>**3.5a** | <br><br>For both Allow independent/not independent. Do NOT allow relationship in place of association<br>BC Accept awrt 6.45<br>Can be implied by correct critical value<br>Allow $\chi^2_2(6.4508) = 0.9603$<br>With the above allow comparison with 95% so reject for $H_0$ M1<br>Must have correct test statistic and critical value<br>If hypotheses wrong way around allow MAX B0B1B1B1M0A0 |
| 10 | (d) | | For low dietary fat, the contribution of 1.0563 shows that more people than expected have normal cholesterol level whereas the contribution of 1.2071 shows that fewer than expected have high cholesterol level.<br>For medium dietary fat, the numbers are as expected.<br>For high dietary fat, the contribution of 1.8240 shows that fewer people than expected have normal cholesterol level whereas the contribution of 2.0846 shows that more than expected have high cholesterol level | **B3,2,1,0**<br><br>**[3]** | **2.2b**<br><br>**3.5a**<br>**3.5a** | B3 for 5 correct contribution comments<br>B2 for 4 correct contribution comments<br>B1 for two correct comments<br><br>Allow slightly fewer with higher and slightly more with normal |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AOs</th><th>Guidance</th></tr>
<tr><td>11</td><td>(a)</td><td></td><td>A Wilcoxon (signed rank) test should be carried out since this test does not require the population to be Normally distributed,<br>and the Normal probability plot is not roughly straight and the p-value is rather low<br>which both suggest that the data does not come from a Normal distribution</td><td>B1<br><br>E1<br><br>E1<br>[3]</td><td>3.3<br><br>1.1<br><br>2.2b</td><td>B0E0E0 if suggest using a t test even if reasons as below</td></tr>
<tr><td>11</td><td>(b)</td><td></td><td>$H_0$: population median is 1<br>$H_1$: population median is less than 1<br><table><tr><td>Value</td><td>Val–1</td><td>Abs</td><td>Rank</td></tr><tr><td>–0.84</td><td>–1.84</td><td>1.84</td><td>10</td></tr><tr><td>–0.76</td><td>–1.76</td><td>1.76</td><td>9</td></tr><tr><td>–0.16</td><td>–1.16</td><td>1.16</td><td>8</td></tr><tr><td>0.43</td><td>–0.57</td><td>0.57</td><td>4</td></tr><tr><td>1.31</td><td>0.31</td><td>0.31</td><td>1</td></tr><tr><td>1.32</td><td>0.32</td><td>0.32</td><td>2</td></tr><tr><td>1.47</td><td>0.47</td><td>0.47</td><td>3</td></tr><tr><td>1.64</td><td>0.64</td><td>0.64</td><td>5</td></tr><tr><td>1.93</td><td>0.93</td><td>0.93</td><td>6</td></tr><tr><td>2.14</td><td>1.14</td><td>1.14</td><td>7</td></tr></table><br>$W_- = 10 + 9 + 8 + 4 = 31$<br>$W_+ = 1 + 2 + 3 + 5 + 6 + 7 = 24$<br>Test statistic = $W_- = 24$ or $W_+ = 31$<br>For comparing $24 > 10$ or $31 < 45$<br><br>So do not reject $H_0$<br>Insufficient evidence to suggest that the dietary supplement causes an increase of less than 1 kg in lean body mass</td><td>B1<br>B1<br><br>M1<br><br><br><br><br><br><br><br><br>M1<br><br>A1<br>M1<br><br><br>A1<br><br>[7]</td><td>3.3<br>2.5<br><br>1.1<br><br><br><br><br><br><br><br><br>1.1<br><br>1.1<br>3.4<br><br><br>3.5a</td><td>Population median used<br>Both correct Max B1B0 if population not mentioned<br>NB No marks for test based on Normal distribution<br><br>For attempt at ranking<br><br><br><br><br><br><br><br><br>Attempt to calculate either $W_+$ or $W_-$<br><br><br>Critical value is 10 or 45 Dep on sensible attempt at Wilcoxon, including finding ranks<br><br>Test statistic must be correct<br>Allow ‘insufficient evidence to suggest that the researcher’s belief is correct’</td></tr>
<tr><td>11</td><td>(c)</td><td></td><td>(Single sample) t test<br>$H_0$: $\mu = 1$ kg<br>$H_1$: $\mu < 1$ kg<br>where $\mu$ is population mean increase in body mass</td><td>E1<br>E1<br><br>E1<br>[3]</td><td>2.2a<br>1.2<br><br>1.1</td><td>All marks are independent<br>$H_0$: Mean increase in body mass in population = 1 kg<br>$H_1$: Mean increase in body mass in population < 1 kg</td></tr>
</table>

| Question | | | Answer | Marks | AOs | Guidance |
|---|---|---|---|---|---|---|
| 12 | (a) | | $k(a\times a-0.5a^2)=1$ | M1 | 3.1a | Do not allow any credit if no attempt to find $k$ |
| | | | $k=\frac{2}{a^2}$ | A1 | 1.1 | |
| | | | $\frac{2}{a^2}(am-0.5m^2)=0.5$ | B1 | 1.1 | |
| | | | $(am-0.5m^2)=0.25a^2$ $[\Rightarrow 2m^2-4am+a^2=0]$ | M1 | 1.1 | |
| | | | $2(m-a)^2-a^2=0$ | M1 | 2.1 | For attempt to solve by formula or completing the square |
| | | | $m=a\pm\sqrt{0.5}a=a\pm\frac{\sqrt{2}}{2}a=a\left(\frac{2\pm\sqrt{2}}{2}\right)$ | M1 | 1.1 | For at least one correct solution |
| | | | $m=a-\sqrt{0.5}a=a-\frac{\sqrt{2}}{2}a=a\left(\frac{2-\sqrt{2}}{2}\right)$ | A1<br>[7] | 3.2a | For choosing correct answer |
| 12 | (b) | | $\mathrm{f}(x)=\frac{1}{50}(10-x)=\frac{1}{5}-\frac{1}{50}x$ | B1 | 3.1a | No credit if f($x$) not found Can be in terms of $k$ in place of $\frac{1}{50}$ |
| | | | $\mathrm{E}(X)=\int_0^{10}\frac{1}{50}(10x-x^2)\,\mathrm{d}x$ | M1 | 1.1 | With their two term f($x$) Can be in terms of $k$ in place of $\frac{1}{50}$ for M1 |
| | | | $=3.333=\frac{10}{3}$ | A1 | 1.1 | BC |
| | | | $\mathrm{E}(X^2)=\int_0^{10}\frac{1}{50}(10x^2-x^3)\,\mathrm{d}x$ [ = 16.667] | M1 | 1.1 | With their two term f($x$) Can be in terms of $k$ in place of $\frac{1}{50}$ for M1 |
| | | | $\mathrm{Var}(X)=16.667-3.333^2=5.556=\frac{50}{9}$<br>Standard deviation = 2.357 | A1 | 1.1 | |
| | | | P(within 1 sd of mean) = P(0.97631 < $X$ < 5.69036) | M1 | 3.3 | Dep on mean and sd correct.<br>Or P $\left(\frac{10-5\sqrt{2}}{3}<X<\frac{10+5\sqrt{2}}{3}\right)$ |
| | | | $=0.02(10\times5.69036-0.5\times5.69036^2$<br>$-0.02(10\times0.97631-0.5\times0.97631^2)$ | | | |
| | | | = 0.81426… – 0.18573… = 0.6285 | A1<br>[7] | 1.1 | Allow exact answer $\frac{4}{9}\sqrt{2}$ |

**Need to get in touch?**

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

**Call us on**

**01223 553998**

**Alternatively, you can email us on**

**support@ocr.org.uk**

**For more information visit**

**ocr.org.uk/qualifications/resource-finder**

**ocr.org.uk**

**Twitter/ocrexams**

**/ocrexams**

**/company/ocr**

**/ocrexams**

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored. © OCR 2022 Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England. Registered office The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA.

Registered company number 3484466. OCR is an exempt charity.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up-to-date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please contact us.

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our Expression of Interest form.

Please get in touch if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.