# Mark Scheme (Results)

## Summer 2018

Pearson Edexcel International A Level
In Mathematics
Statistics S3 (WST03/01)

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June 2018
# WST03/01 Statistics 3
# Mark Scheme

## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.

- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.

- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.

- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.

- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. **Examiners should also be prepared to award zero marks if the candidate's response is** not worthy of credit according to the mark scheme.

- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.

- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

# EDEXCEL IAL MATHEMATICS

## General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M marks: method marks are awarded for 'knowing a method and attempting to apply it',** unless otherwise indicated.
- A marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- B marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\sqrt{}$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ✱ The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. **All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to** indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

# June 2018 IAL - WST03/01 Statistics 3

| Question Number | Scheme | | | | | | | | | | | Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** (a) | Footballer | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | | |
| | Rank *x* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
| | Rank *y* | 6 | 9 | 8 | 2 | 5 | 4 | 7 | 3 | 1 | | M1 |
| | Rank *x* | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | | |
| | Rank *y* | 4 | 1 | 2 | 8 | 5 | 6 | 3 | 7 | 9 | | |

| | | Marks |
|---|---|---|
| | $\sum d^2 = 25 + 49 + 25 + 4 + 0 + 4 + 0 + 25 + 64 = 196$ | M1 A1 |
| | $r_{\text{S}} = 1 - \dfrac{6(196)}{9(9^2 - 1)} ;= -0.63333333...\quad \text{or}\quad -\dfrac{19}{30}$ | dM1; A1 |
| | | **[5]** |
| (b) | $H_0 : \rho_{\text{s}} = 0, \quad H_1 : \rho_{\text{s}} < 0$ | B1 |
| | Critical Value $= -0.6000$ or $-0.6$ or CR: $r_{\text{S}} \leqslant -0.6000$ | B1 |
| | Since $r_{\text{S}} = -0.6333...$ lies in the CR (or $-0.6333 < -0.6$), reject $H_0$ | M1 |
| | Either conclude that <br> • <u>Russell's claim</u> is <u>true</u> <br> • Footballers with <u>lower BMI are slower</u>      Conclusion in context | A1 |
| | | **[4]** |
| (c) | **Both** Critical Value $r = -0.5822$ /CR: $r \leqslant -0.5822$ **and** <br> <u>does not lie in the CR</u> /Result is <u>not significant</u>/<u>Do not reject $H_0$</u> (or accept $H_0$) | M1 |
| | Conclude that there is <u>no negative correlation</u> oe      Context not required here. | A1 |
| | | **[2]** |
| (d) | The relationship (between BMI and time taken to complete the obstacle course) is non-linear oe | B1 |
| | | **[1]** <br> **12** |

| | **Question 1 Notes** | |
|---|---|---|
| **1.** (a) | **1ˢᵗ M1** | Attempt to rank data for *x* and *y* at least 5 correct for each (allow reverse rankings) |
| | **2ⁿᵈ M1** | For finding the difference between each of the ranks and evaluating $\sum d^2$ |
| | **1ˢᵗ A1** | $\sum d^2 = 196$   or from reverse rankings $\sum d^2 = 9 + 1 + 1 + 16 + 0 + 0 + 16 + 1 + 0 = 44$ |
| | **3ʳᵈ dM1** | *is dependent on 1ˢᵗ M1* for use of $1 - \dfrac{6("196")}{9(9^2 - 1)}$ with their $\sum d^2$. |
| | **2ⁿᵈ A1** | awrt $-0.633$ or $-\dfrac{19}{30}$   or from reverse rankings $\dfrac{19}{30}$ |
| (b) | **1ˢᵗ B1** | Both hypotheses stated in terms of $r$ or $\rho_{\text{s}}$. |
| | **Note** | One tail $H_1$ must be compatible with their ranking. |
| | **2ⁿᵈ B1** | Critical value of $\pm 0.6$ |
| | **M1** | For a correct statement relating their $r_S$ $\left(|r_S| < 1\right)$ with their c.v. where $|\text{their c.v.}| < 1$ |
| | **A1** | For a contextualised comment which is rejecting $H_0$, which must mention either "<u>negative correlation</u>", "<u>BMI</u>" and "<u>time</u>" **or** "<u>lower BMI are slower</u>" o.e. |
| | **Note** | Follow through their $r_S$ with their c.v. (provided $|\text{their c.v.}| < 1$) |
| (c) | **M1** | Allow $\pm 0.5822$      Ignore hypotheses in this part for the M1 <br> Use of $-0.633$ here is M0 |

| Question Number | Scheme | Marks |
|---|---|---|
| **2.** (a) | $\hat{p} = \dfrac{7(3)+8(5)+9(18)+10(28)+11(17)+12(4)}{12(3+5+18+28+17+4) \text{ or } 12(75)} \left\{= \dfrac{738}{900}\right\} = 0.82\,(^*)$    Answer is given. See notes. | M1 A1cso **[2]** |
| (b) | $r = 75 \times {}^{12}C_9(0.82)^9(0.18)^3 \left\{= 16.1296941...\right\}$ (formula) <br><br> $s = 75 - (2.80 + 7.97 + \text{their } r + 22.04 + 18.26 + 6.93)$ | M1 |
| | $r = 16.1296941...$ ; $s = 0.87...$      $r = \text{awrt } 16.13$ ; $s = \text{awrt } 0.87$ | A1; A1 **[3]** |
| (c) | $H_0$: Binomial distribution is a suitable (or good) model (or fit) <br> $H_1$: Binomial distribution is not a suitable model | B1 |

| # | $O_i$ | $E_i$ | Comb $O_i$ | Comb $E_i$ | $\dfrac{(O_i - E_i)^2}{E_i}$ | $\dfrac{O_i^2}{E_i}$ | |
|---|---|---|---|---|---|---|---|
| $\leqslant 6$ | 0 | 0.87 | | | | | |
| 7 | 3 | 2.80 | 8 | 11.64 | 1.1383… | 5.4983… | M1 |
| 8 | 5 | 7.97 | | | | | |
| 9 | 18 | 16.13 | 18 | 16.13 | 0.2168… | 20.0868… | |
| 10 | 28 | 22.04 | 28 | 22.04 | 1.6117… | 35.5717… | M1 |
| 11 | 17 | 18.26 | 17 | 18.26 | 0.0869… | 15.8269… | |
| 12 | 4 | 6.93 | 4 | 6.93 | 1.2388... | 2.3088... | |
| | | | | **Totals** | 4.2925... | 79.2925... | |

| | | |
|---|---|---|
| $X^2 = \text{awrt } 4.3$ | | A1 |
| $v = 5 - 1 - 1 = 3$ | | B1 ft |
| $\chi^2_3(0.10) = 6.251 \Rightarrow \text{CR: } X^2 \geqslant 6.251$ | | B1 ft |
| [does not lie in the CR/not significant/Do not reject $H_0$/Accept $H_0$] | | |
| Binomial distribution is a suitable model. | A correct conclusion (context not required here) which is based on *their* $X^2$-value and *their* $\chi^2$-critical value. | A1 |
| | | **[7]** **12** |

<center>**Question 2 Notes**</center>

| | | |
|---|---|---|
| **2.** (a) | **M1** | At least 2 non zero products on the numerator and correct division for their method |
| | **A1 cso** | Correct answer $p = 0.82$ with no incorrect working seen |
| (b) | **M1** | For any correct method (or a correct expression) for finding either $r$ or $s$. |
| | **A1; A1** | $r = \text{awrt } 16.13$ ; $s = \text{awrt } 0.87$ |
| (c) | **1st B1** | Must have both hypotheses and mention Binomial at least once. <br> Inclusion of 0.82 for $p$ in hypotheses is B0 but condone in conclusion. |
| | **1st M1** | For an attempt to pool 8, 7 and $\leqslant 6$ germinating seeds ONLY. |
| | **2nd M1** | For an attempt at the test statistic, at least 2 correct expressions/values <br> (to awrt 2 d.p. or truncated 2 d.p.) |
| | **1st A1** | awrt 4.3 |
| | **2nd B1ft** | For their evaluated $n - 1 - 1$. i.e. realising that they must subtract 2 from their $n$. |
| | **3rd B1ft** | For a correct ft for their $\chi^2_k(0.10)$, from their degrees of freedom |
| | **Note** | For 0.10 significance: $\chi^2_6 = 10.645$   $\chi^2_5 = 9.236$   $\chi^2_4 = 7.779$   $\chi^2_2 = 4.605$ |
| | **Final A1** | *Dependent on the 2nd Method mark only.* <br> A correct conclusion (context not required) which is accepting $H_0$ |
| | **Note** | No follow through on their hypotheses if they are stated the wrong way round. |
| | **Note** | Contradictory statements score A0. E.g. "significant, do not reject $H_0$". |
| | **Note** | Condone mentioning of B(12, 0.82) in conclusion. |

| Question Number | Scheme | Marks |
|---|---|---|
| **3.** (a) | $\left\{ \hat{m}_x = \bar{x} = \dfrac{92.0}{20} \Rightarrow \right\}$ $\bar{x} = 4.6$ (cm)      4.6 | B1 |
| | $\left\{ \hat{S}_x{}^2 = \right\}$ $s_x{}^2 = \dfrac{433.4974 - 20(4.6)^2}{20-1} = 0.541968...$ (cm)$^2$    Applies $\dfrac{â x^2 - 20(\text{their } \bar{x})^2}{20-1}$ | M1 |
| | awrt **0.542** | A1 |
| | | **[3]** |
| (b) | Combined Sample: Mean $= \dfrac{92.0 + 142.5}{20+30} = 4.69$      4.69 Can be implied. | B1 |
| | $s^2 = \dfrac{433.4974 + 689.5078 - 50(4.69)^2}{20+30-1}$ ; $= 0.4734734694$    awrt 0.473 or 0.4735 (can be implied) | M1; A1 |
| | $\dfrac{s}{\sqrt{n}} = \dfrac{\sqrt{0.4734734694...}}{\sqrt{50}}$ ; $= 0.09731119868...$    For use of $s/\sqrt{50}$    awrt **0.0973** | M1; A1 |
| | | **[5]** |
| (c) | $H_0 : m = 4.5$    $H_1 : m > 4.5$      Correct hypotheses | B1 |
| | $z = \dfrac{"4.69" - 4.5}{\dfrac{0.71}{\sqrt{50}}}$ ; $= 1.892257583...$    $\pm \dfrac{\text{their } 4.69 - 4.5}{\dfrac{0.71}{\sqrt{50}}}$ or equivalent. | M1; |
| | awrt **1.89** | A1 |
| | One tailed c.v. $Z = 1.6449$ or CR: $Z \geqslant 1.6449$ or p-value = awrt 0.029 or awrt $0.029 < 0.05$    Critical value of 1.6449 or a correct probability comparison. | B1 |
| | [in the CR/significant/Reject $H_0$/ $0.029 < 0.05$] | |
| | Conclude either<br>• there is evidence to <u>support</u> the <u>farmer's claim</u><br>• that the <u>mean width</u> of duck <u>eggs</u> is <u>greater than 4.5</u> cm.    A correct conclusion which is rejecting $H_0$ in context and is based on ***their*** $z$-value and ***their*** critical value, where $\lvert\text{c.v.}\rvert > 1$. | A1 |
| | | **[5]** |
| | | **13** |
| | **Question 3 Notes** | |
| **3.** (a) | **M1**    Also allow M1 for applying $\dfrac{20}{(20-1)}\left( \dfrac{\sum x^2}{20} - (\text{their } \bar{x})^2 \right)$ | |
| (b) | **1st M1**    Also allow 1st M1 for applying $\dfrac{50}{(50-1)}\left( \dfrac{\sum x^2 + \sum y^2}{20+30} - (\text{their } \bar{x}_{\text{comb}})^2 \right)$ | |
| | **Note**    Award B1M1A1M1A1 for awrt 0.0973 which follows from no working. | |
| (c) | **1st M1**    Condone use of 4.6 for this M1 mark.<br>**2nd A1**    Conclusion must refer to either "farmer's claim" oe or "mean width" and "eggs". | |

| Question Number | Scheme | Marks |
|---|---|---|
| **4.** (a) | $H_0$ : <u>Mean number</u> of reported first-aid <u>incidents</u> per 1000 employees is the <u>same</u> at each warehouse. <br> $H_1$ : <u>Mean</u> number of reported first-aid incidents per 1000 employees is <u>not the same</u>. | B1 |

|  | Warehouse | Calculation | Expected | Some attempt at using the correct formula to find their 5 expected values (expected number of incidents). Can be implied by at least one correct $E_i$. | M1 |
|---|---|---|---|---|---|
|  | *A* | $\dfrac{(2)(114)}{12}$ | 19 |  |  |
|  | *B* | $\dfrac{(1)(114)}{12}$ | 9.5 |  |  |
|  | *C* | $\dfrac{(3.8)(114)}{12}$ | 36.1 | All expected frequencies are correct. | A1 |
|  | *D* | $\dfrac{(3)(114)}{12}$ | 28.5 |  |  |
|  | *E* | $\dfrac{(2.2)(114)}{12}$ | 20.9 |  |  |

| Observed | Expected | $\dfrac{(O-E)^2}{E}$ | $\dfrac{O^2}{E}$ | Dependent upon previous M1 At least 3 correct terms for $\dfrac{(O-E)^2}{E}$ or $\dfrac{O^2}{E}$ Accept 2 sf accuracy for the dM1 mark. | dM1 |
|---|---|---|---|---|---|
| 15 | 19 | 0.8421… | 11.8421… |  |  |
| 10 | 9.5 | 0.0263... | 10.5263... |  |  |
| 40 | 36.1 | 0.4213… | 44.3213… |  |  |
| 26 | 28.5 | 0.2193... | 23.7193... |  |  |
| 23 | 20.9 | 0.2110… | 25.3110… |  |  |
|  | Totals | 1.7200… | 115.72… |  |  |

$X^2 = \sum \dfrac{(O-E)^2}{E}$  or  $\sum \dfrac{O^2}{E} - 114 =$ awrt 1.72 → awrt **1.72** | A1

$n = 5 - 1 = 4 \;\triangleright\; \chi^2_4(0.05) = 9.488 \Rightarrow$ CR: $X^2 \geqslant 9.488$ → **9.488** | B1

[not in the CR/not significant/Do not Reject $H_0$ /Accept $H_0$ ]

Conclude either:
- <u>manager's claim</u> is <u>supported</u>
- that the mean number of reported first-aid incidents per 1000 employees <u>is the same</u> at each warehouse.

A correct conclusion in context which is based on *their* $X^2$ value and *their* $\chi^2$-critical value. | A1 ft

**[7]**

| (b) | Select <u>every 4<sup>th</sup> record</u> from warehouse *C*. | B1 |
|---|---|---|
|  | {having chosen the first record by} |  |
|  | selecting a random number. | dB1 |
|  |  | **[2]** |
|  |  | **9** |

**Question 4 Notes**

(a)
**SC 1**  Expected values of 9.5 used

| Observed | Expected | $\dfrac{(O-E)^2}{E}$ |
|----------|----------|----------------------|
| 7.5      | 9.5      | 0.4210…              |
| 10       | 9.5      | 0.0263...            |
| 10.5…    | 9.5      | 0.1108…              |
| 8.6…     | 9.5      | 0.0730...            |
| 10.4…    | 9.5      | 0.0959…              |
|          | Totals   | 0.727…               |

Can score B1M1A0M1A0B1A1ft (5 out of 7)

**SC 2**  Expected values of 9.43… used

| Observed | Expected | $\dfrac{(O-E)^2}{E}$ | $\dfrac{O^2}{E}$ |
|----------|----------|----------------------|------------------|
| 7.5      | 9.43     | 0.3948…              | 5.965…           |
| 10       | 9.43     | 0.0345...            | 10.6050...       |
| 10.5…    | 9.43     | 0.1275…              | 11.7507…         |
| 8.6…     | 9.43     | 0.0617...            | 7.9655...        |
| 10.4…    | 9.43     | 0.1114…              | 11.5910…         |
|          | Totals   | 0.729…               | 47.877…          |

Can score B1M1A0M1A0B1A0 (4 out of 7)

**(b)**  Use of 3800 in part (b) is B0B0

| Question Number | Scheme | | Marks |
|---|---|---|---|
| **5.** | 95% CI for $m$ is $(30.612, 31.788)$; $c\%$ CI for $m$ is $(30.66, 31.74)$ | | |
| (a) | $\dfrac{2(1.96)s}{\sqrt{25}} = 31.788 - 30.612 \left\{= 1.176\right\}$ | $\dfrac{2"z"s}{\sqrt{25}} = 31.788 - 30.612$ | M1 oe |
| | | 1.96 | B1 |
| | $\left\{\Rightarrow s = \dfrac{(1.176)(5)}{2(1.96)} \Rightarrow\right\} s = 1.5$ | $s = 1.5$ | A1 |
| | | | **[3]** |
| (b) | $\dfrac{2z(1.5)}{\sqrt{25}} = 31.74 - 30.66 \left\{= 1.08\right\}$ | $\dfrac{2z("1.5")}{\sqrt{25}} = 31.74 - 30.66$ | M1 oe |
| | $z = \dfrac{(1.08)(5)}{2("1.5")} \rightarrow z = 1.8$ | $z = 1.8$ | A1ft |
| | $\left\lfloor \dfrac{c}{100} = \right\rfloor 2(0.9641) - 1$ | $2F(\text{their "1.8"}) - 1$ oe | M1 |
| | $\triangleright\ c = 92.8$ (3sf) | awrt **92.8** | A1 |
| | | | **[4]** |
| | | | **7** |

| | | **Question 5 Notes** | |
|---|---|---|---|
| **5.** (a) | **M1** | Also allow M1 (oe) for $31.2 + \dfrac{\text{"their }z"s}{\sqrt{25}} = 31.778$, where $31.2 = \dfrac{30.612 + 31.778}{2}$ | |
| (b) | **1$^{st}$ M1** | Also allow M1 (oe) for $31.2 + \dfrac{z(\text{their "1.5"})}{\sqrt{25}} = 31.74$, where $31.2 = \dfrac{30.66 + 31.74}{2}$ | |
| | **1$^{st}$ A1ft** | For a correct (ft) expression using their value of $\sigma$ | |
| | **2$^{nd}$ M1** | awrt 0.928 implies this mark | |
| | **Note** | Use of 1.6449 gives $\sigma = 1.787...$ and leads to $z = 1.51...$ and $c = 86.9$ (3sf) (M1A1ftM1A0) | |

| Question Number | Scheme | Marks |
|---|---|---|
| **6.** | $Y$ has a continuous uniform distribution $\left[\,a - 3,\; a + 6\,\right]$ | |
| (a) | $E(Y) = \dfrac{a + 6 + a - 3}{2}\;\left\{= \dfrac{(2a + 3)}{2}\ \text{or}\ a + \dfrac{3}{2}\right\}$ | M1 |
| | $Var(Y) = \dfrac{(a + 6 - a + 3)^2}{12}\;\left\{= \dfrac{81}{12}\ \text{or}\ \dfrac{27}{4}\ \text{or}\ 6.75\right\}$      May be implied | M1 |
| | $\bar{Y} \sim N\!\left(a + \dfrac{3}{2},\ \dfrac{9}{80}\right)$      $N\!\left(a + \dfrac{3}{2},\ \dfrac{9}{80}\right)$ | A1 |
| | | **[3]** |
| (b) | $13.4 - 2.3263\sqrt{\dfrac{9}{80}}\; <\; \text{m} \;<\; 13.4 + 2.3263\sqrt{\dfrac{9}{80}}$     $13.4 \pm "z" (\text{their } SE_{\bar{Y}})$ | M1 |
| | | 2.3263   B1 |
| | $13.4 - 2.3263\sqrt{\dfrac{9}{80}}\; <\; a + \dfrac{3}{2} \;<\; 13.4 + 2.3263\sqrt{\dfrac{9}{80}}$ | |
| | $13.4 - 2.3263\sqrt{\dfrac{9}{80}} + 4.5\; <\; a + 6 \;<\; 13.4 + 2.3263\sqrt{\dfrac{9}{80}} + 4.5$    $13.4 \pm "z" (\text{their } SE_{\bar{Y}}) + 4.5$ | M1 |
| | $17.11973576... < a + 6 < 18.68026474...$      awrt $(17.1, 18.7)$ | A1 |
| | | **[4]** |
| (b) | **Alternative Method for part (b)** | |
| | $13.4 - 2.3263\sqrt{\dfrac{9}{80}}\; <\; \text{m} \;<\; 13.4 + 2.3263\sqrt{\dfrac{9}{80}}$     $13.4 \pm "z" (\text{their } SE_{\bar{Y}})$ | M1 |
| | | 2.3263   B1 |
| | $11.11973526... < a < 12.68026474...$ | |
| | $11.11973526... + 6 < a + 6 < 12.68026474... + 6$    $13.4 \pm "z" (\text{their } SE_{\bar{Y}}) - 1.5 + 6$ | M1 |
| | $17.11973576... < a + 6 < 18.68026474...$      awrt $(17.1, 18.7)$ | A1 |
| | | **[4]** |
| | | **7** |

| | **Question 6 Notes** |
|---|---|
| (b) | 1st M1   The inequalities may be seen separately. For only considering 1-tail of confidence interval (usually the upper tail) allow access to 1st M1 only (so M1B1M0A0 is possible). <br>      A second division of their $SE$ by 60 is 1st M0 |

| Question Number | Scheme | | Marks |
|---|---|---|---|
| **7.** (i) (a) | $A$  N$(21, 2^2)$,  $B$  N$(32, 7^2)$ and  $C$  N$(45, 9^2)$ *A, B, C* are independent. | | |
| | $T = A + B + C$ | | |
| | E$(T) = 21 + 32 + 45$ or  Var$(T) = 2^2 + 7^2 + 9^2$ | A fully correct method of finding E$(T)$ or Var$(T)$ | M1 |
| | E$(T) = 98$ and  Var$(T) = 134$ | Both  E$(T) = 98$  and  Var$(T) = 134$ | A1 |
| | {So $T \sim$ N$(98, 134)$ } | | |
| | {P$(T > 90) = $ }  P$\left( Z > \dfrac{90 - 98}{\sqrt{134}} \right)$ | Standardising $(\pm)$ with their mean and their standard deviation | M1 |
| | $= $ P$(Z > -0.69109...)$ | | |
| | $= 0.7549$ (or 0.75525...) | awrt **0.755** | A1 |
| | | | **[4]** |
| (b) | $\{$P$(A > B) = $ P$(A - B > 0)\}$ | | |
| | E$(A - B) = 21 - 32$ or  Var$(T) = 2^2 + 7^2$ | A fully correct method of finding E$(A - B)$ or Var$(A - B)$ | M1 |
| | E$(A - B) = -11$ and  Var$(A - B) = 53$ | Both E$(A - B) = -11$ and  Var$(A - B) = 53$ | A1 |
| | {So $A - B$  N$(-11, 53)$} | | |
| | $\{$P$(A - B > 0)$ $\}$ $\Rightarrow$ P$\left( Z > \dfrac{0 - -11}{\sqrt{53}} \right)$ | Standardising $(\pm)$ with their mean and their standard deviation | M1 |
| | $= $ P$(Z > 1.510966...)$ | | |
| | $= 0.06539855¼$ (or 0.0655) | **0.0655** or awrt **0.0654** | A1 |
| | | | **[4]** |
| (ii) | $\left\{ \text{P}\left( X_1 > \bar{X} + kS \right) = 0.1 \triangleright \text{P}\left( X_1 - \bar{X} > kS \right) = 0.1 \right\}$ | | |
| | $X_1 - \bar{X}; \left\{ = X_1 - \dfrac{(X_1 + X_2 + X_3 + X_4)}{4} = \dfrac{3X_1 - (X_2 + X_3 + X_4)}{4} \right\}$ | For attempting to find the distribution of $X_1 - \bar{X}$ | M1 |
| | E$(X_1 - \bar{X}) = 0$ | Correct mean | A1 |
| | Var$(X_1 - \bar{X}) = \dfrac{9\sigma^2 + 3\sigma^2}{4^2};$ $\Rightarrow X_1 - \bar{X} \sim$ N$\left( 0, 0.75\sigma^2 \right)$ | Correct expression for Var$(X_1 - \bar{X})$ | dM1 |
| | | $X_1 - \bar{X}$  N$\left( 0, 0.75S^2 \right)$ | A1 |
| | $\left\{ \text{P}\left( X_1 - \bar{X} > kS \right) = 0.1 \Rightarrow \text{P}\left( Z > \dfrac{kS - 0}{\sqrt{0.75S^2}} \right) = 0.1 \right\}$ | | |
| | So, $\dfrac{k}{\sqrt{0.75}} = 1.2816$ | Standardising using their $\sqrt{\text{Var}(X_1 - \bar{X})}$. Note that $S$ must cancel and equating to a $z$-value, $|z| > 1$. | M1 |
| | | 1.2816 | B1 |
| | $\left\{ k = \sqrt{0.75} \, (1.2816) \right\} \triangleright k = 1.109898157...$ | awrt **1.11** | A1 |
| | | | **[7]** |
| | | | **15** |
| | **Question 7 Notes** | | |
| **7.** (i) (a) | **1$^{\text{st}}$ M1** | Can be implied by either a correct E$(T)$ or Var$(T)$ | |
| (i) (b) | | Allow equivalent method using $B - A < 0$ | |
| (ii) | **Final A1** | Dependent upon all previous M marks in (ii) | |