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**MATHEMATICS**

**9709/62**

Paper 6

**May/June 2017**

MARK SCHEME

Maximum Mark: 50

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**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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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## **Mark Scheme Notes**

Marks are of the following three types:

**M** Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

**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).

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

- When a part of a question has two or more “method” steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep\*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously “correct” answers or results obtained from incorrect working.
  - Note: B2 or A2 means that the candidate can earn 2 or 0.  
B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking  $g$  equal to 9.8 or 9.81 instead of 10.

The following abbreviations may be used in a mark scheme or used on the scripts:

|        |   |
|--------|---|
| AEF/OE | Any Equivalent Form (of answer is equally acceptable) / Or Equivalent   |
| AG     | Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)   |
| CAO    | Correct Answer Only (emphasising that no “follow through” from a previous error is allowed)   |
| CWO    | Correct Working Only – often written by a ‘fortuitous’ answer   |
| ISW    | Ignore Subsequent Working   |
| SOI    | Seen or implied   |
| SR     | Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance) |

### **Penalties**

- MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become “follow through” marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR –2 penalty may be applied in particular cases if agreed at the coordination meeting.
- PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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| Question | Answer  | Marks     | Guidance  |
|----------|---|-----------|---|
| 1(i)     | $4 \times 5.5 + 3x + 90 = 8 \times 29$                    | <b>M1</b> | An expression to work out total cost of individual items = $8 \times$ mean, $x$ may be implied. |
|          | $112 + 3x = 232$<br>$x = 40$                              | <b>A1</b> | Correct complete unsimplified expression / calculation  |
|          | (Cost = \$)40   | <b>A1</b> | Units not required  |
|          | <b>Total:</b>   | <b>3</b>  |   |
| 1(ii)    | sd = 0 so all cost the same                               | <b>M1</b> | Must see comment interpreting sd = 0, OE  |
|          | shirts cost $4 \times \$26 = \$104$ <b>AG</b>             | <b>A1</b> | See $4 \times \$26$ , \$130 – \$26 OE. Must have a final value of \$104 stated                  |
|          | <b>Total:</b>   | <b>2</b>  |   |
| 2(i)     | med = 3.2   | <b>B1</b> | Accept $3.2 \pm 0.05$   |
|          | $UQ = 3.65 \leq uq \leq 3.7$ $LQ = 2.55 \leq lq \leq 2.6$ | <b>M1</b> | UQ – LQ, UQ greater than <i>their</i> ‘median’, LQ less than <i>their</i> ‘median’              |
|          | $IQR = 1.05 \leq iqr \leq 1.15$                           | <b>A1</b> | Correct answer from both LQ and UQ in given ranges  |
|          | <b>Total:</b>   | <b>3</b>  |   |
| 2(ii)    | $134 - 24 = 110$  | <b>B1</b> | Accept $108 \leq n \leq 112$ , $n$ an integer   |
|          | <b>Total:</b>   | <b>1</b>  |   |

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| Question      | Answer   | Marks     | Guidance  |      |       |   |      |      |     |      |       |           |   |
|---------------|--|-----------|---|------|-------|---|------|------|-----|------|-------|-----------|---|
| 2(iii)        | $200 - 12 = 188$ less than length $l$  | <b>M1</b> | 188 seen, can be implied by answer in range, mark on graph.   |      |       |   |      |      |     |      |       |           |   |
|               | $l = 4.5$ cm   | <b>A1</b> | Correct answer accept $4.4 \leq l \leq 4.5$   |      |       |   |      |      |     |      |       |           |   |
|               | <b>Total:</b>  | <b>2</b>  |   |      |       |   |      |      |     |      |       |           |   |
| 3(i)          | $k(-2)^2$ is the same as $k(2)^2 = 4k$   | <b>B1</b> | need to see $-2^2 k$ , $2^2 k$ and $4k$ , algebraically correct expressions OE                      |      |       |   |      |      |     |      |       |           |   |
|               | <b>Total:</b>  | <b>1</b>  |   |      |       |   |      |      |     |      |       |           |   |
| 3(ii)         | <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td><math>x</math></td> <td>-2</td> <td>-1</td> <td>2</td> <td>4</td> </tr> <tr> <td>Prob</td> <td><math>4k</math></td> <td><math>k</math></td> <td><math>4k</math></td> <td><math>16k</math></td> </tr> </table> | $x$       | -2  | -1   | 2     | 4 | Prob | $4k$ | $k$ | $4k$ | $16k$ | <b>B1</b> | -2, -1, 2, 4 only seen in a table, together with at least one attempted probability involving $k$ |
|               | $x$  | -2        | -1  | 2    | 4     |   |      |      |     |      |       |           |   |
|               | Prob   | $4k$      | $k$   | $4k$ | $16k$ |   |      |      |     |      |       |           |   |
|               | $4k + k + 4k + 16k = 1$  | <b>M1</b> | Summing 4 probs equating to 1. Must all be positive (table not required)                            |      |       |   |      |      |     |      |       |           |   |
|               | $k = 1/25$ (0.04)  | <b>A1</b> | CWO   |      |       |   |      |      |     |      |       |           |   |
| <b>Total:</b> | <b>3</b>   |           |   |      |       |   |      |      |     |      |       |           |   |
| 3(iii)        | $E(X) = -8k + -k + 8k + 64k = 63k$   | <b>M1</b> | using $\sum px$ unsimplified. FT their $k$ substituted before this stage, no inappropriate dividing |      |       |   |      |      |     |      |       |           |   |
|               | $= 63/25$ (2.52)   | <b>A1</b> |   |      |       |   |      |      |     |      |       |           |   |
|               | <b>Total:</b>  | <b>2</b>  |   |      |       |   |      |      |     |      |       |           |   |

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| Question | Answer                                       | Marks        | Guidance  |
|----------|--|--------------|---|
| 4        | $P(\text{score is } 6) = P(3, 3)$            | <b>M1</b>    | Realising that score 6 is only $P(3, 3)$  |
|          | $= r^2 = 1/36$<br>$r = 1/6$                  | <b>A1</b>    | Correct ans<br>[SR <b>B2</b> $r = 1/6$ without workings]                                  |
|          | $P(2, 3) + P(3, 2) = 1/9$<br>$qr + rq = 1/9$ | <b>M1</b>    | Eqn involving $qr$ (OE) equated to $1/9$ ( $r$ may be replaced by <i>their</i> 'r value') |
|          | $q/6 + q/6 = 1/9$                            | <b>M1</b>    | Correct equation with <i>their</i> 'r value' substituted                                  |
|          | $q = 1/3$                                    | <b>A1</b>    | Correct answer seen, does <b>not</b> imply previous M's                                   |
|          | $p = 1 - 1/6 - 1/3 = 1/2$                    | <b>B1 FT</b> | FT their $p +$ their $r +$ their $q = 1$ , $0 < p < 1$                                    |
|          | <b>Total:</b>                                |              | <b>6</b>  |
| 5(i)     | $(z =) \frac{4.2 - 3.9}{\sigma}$             | <b>M1</b>    | Standardising, not square root of $\sigma$ , not $\sigma^2$                               |
|          | $z = 0.916$ or $0.915$                       | <b>B1</b>    | Accept $0.915 \leq \pm z \leq 0.916$ seen   |
|          | $\sigma = 0.328$                             | <b>A1</b>    | Correct final answer (allow $20/61$ or $75/229$ )   |
|          | <b>Total:</b>                                |              | <b>3</b>  |

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| Question | Answer   | Marks        | Guidance   |
|----------|--|--------------|--|
| 5(ii)    | $z = 4.4 - 3.9/\text{their } 0.328$ or $z = 3.4 - 3.9/\text{their } 0.328$<br>$= 1.5267$ $= -1.5267$               | <b>M1</b>    | Standardising attempt with 3.4 or 4.4 only, allow square root of $\sigma$ , or $\sigma^2$                            |
|          | $\Phi = 0.9364$  | <b>A1</b>    | $0.936 \leq \Phi \leq 0.937$ or $0.063 \leq \Phi \leq 0.064$ seen  |
|          | $\text{Prob} = 2\Phi - 1 = 2(0.9364) - 1$  | <b>M1</b>    | Correct area $2\Phi - 1$ OE i.e. $\Phi = -(1 - \Phi)$ , linked to final solution                                     |
|          | $= 0.873$  | <b>A1</b>    | Correct final answer from $0.9363 \leq \Phi \leq 0.9365$   |
|          | <b>Total:</b>  | <b>4</b>     |  |
| 5(iii)   | dividing (0.5) by a larger number gives a smaller z-value<br>or more spread out as sd larger<br>or use of diagrams | <b>*B1</b>   | No calculations or calculated values present e.g. $(\sigma = )0.656$ seen<br>Reference to spread or z value required |
|          | Prob is less than that in (ii)   | <b>DB1</b>   | Dependent upon first B1  |
|          | <b>Total:</b>  | <b>2</b>     |  |
| 6(i)     | <i>EITHER</i> : Route 1<br>$A$ ***** $A$ in $9! / 2!2!5! = 756$ ways   | <b>(*M1)</b> | <i>Considering AA and BB options with values</i>   |
|          | $B$ ***** $B$ in $9! / 4!5! = 126$ ways  | <b>A1</b>    | Any one option correct   |
|          | $756 + 126$  | <b>DM1</b>   | <i>Summing their AA and BB outcomes only</i>   |
|          | Total = 882 ways   | <b>A1)</b>   |  |

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| Question | Answer  | Marks       | Guidance   |
|----------|---|-------------|--|
|          | <i>ORI: Route 2</i><br><i>A*****A in <math>{}^9C_5 \times {}^4C_2 = 756</math> ways</i> | <b>(M1)</b> | <i>Considering AA and BB options with values</i> |
|          | <i>B*****B in <math>{}^9C_4 \times {}^5C_5 = 126</math> ways</i>                        | <b>A1</b>   | Any one option correct                           |
|          | 756 + 126   | <b>DM1</b>  | <i>Summing their AA and BB outcomes only</i>     |
|          | Total = 882   | <b>A1)</b>  |  |
|          | <b>Total:</b>   | <b>4</b>    |  |



| Question | Answer   | Marks | Guidance   |
|----------|--|-------|--|
| 6(ii)    | <i>EITHER:</i><br>(The subtraction method)<br>As together, no restrictions $8! / 2!5! = 168$ | (*M1) | Considering all As together – 8! seen alone or as numerator – condone $\times 4!$ for thinking A's not identical |
|          | As together and Bs together $7! / 5! = 42$   | M1    | Considering all As together and all Bs together – 7! seen alone or numerator                                     |
|          |  | M1    | Removing repeated Bs or Cs – Dividing by 5! either expression or 2! 1st expression only – OE                     |
|          | Total 168 – 42   | DM1   | Subt their 42 from their 168 (dependent upon <b>first M</b> being awarded)                                       |
|          | = 126  | A1)   |  |
|          | <i>OR1:</i><br>As together, no restrictions ${}^8C_5 \times {}^3C_1 = 168$                   | (*M1) | ${}^8C_5$ seen alone or multiplied   |
|          |  | M1    | ${}^7C_5$ seen alone or multiplied   |
|          | As together and Bs together ${}^7C_5 \times {}^2C_1 = 42$                                    | M1    | First expression $\times {}^3C_1$ or second expression $\times {}^2C_1$  |
|          | Total 168 – 42   | DM1   | Subt their 42 from their 168 (dependent upon <b>first M</b> being awarded)                                       |
|          | = 126  | A1)   |  |
|          | <i>OR2:</i><br>(The intersperse method )   | (M1)  | Considering all "As together" with Cs – Mult by 6!   |
|          | (AAAA)CCCC then intersperse B and another B  | M1    | Removing repeated Cs – Dividing by 5!– [Mult by 6 implies M2]  |
|          |  | *M1   | Considering positions for Bs – Mult by 7P2 oe –  |

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| Question | Answer  | Marks        | Guidance   |
|----------|---|--------------|--|
|          | $\frac{6!}{5!} \times 7 \times 6 \div 2$  | <b>DM1</b>   | Dividing by 2! Oe – removing repeated Bs (dependent upon <b>3rd M</b> being awarded)   |
|          | = 126   | <b>A1)</b>   |  |
|          | <b>Total:</b>   | <b>5</b>     |  |
| 7(i)     | $P(H) = P(BH) + P(SH) = 0.6 \times 0.05 + 0.4 \times 0.75$                            | <b>M1</b>    | Summing two 2-factor probs using 0.6 with 0.05 or 0.95, and 0.4 with 0.75 or 0.25  |
|          | = 0.330 or $\frac{33}{100}$   | <b>A1</b>    | Correct final answer accept 0.33   |
|          | <b>Total:</b>   | <b>2</b>     |  |
| 7(ii)    | $P(S H) = \frac{P(S \cap H)}{P(H)} = \frac{0.4 \times 0.75}{0.33} = \frac{0.3}{0.33}$ | <b>M1 FT</b> | Their $\frac{P(S \cap H)}{P(H)}$ unsimplified, FT from (i)   |
|          | = $\frac{10}{11}$ or 0.909  | <b>A1</b>    |  |
|          | <b>Total:</b>   | <b>2</b>     |  |
| 7(iii)   | Var (B) = $45 \times 0.6 \times 0.4$<br>Var (S) = $45 \times 0.4 \times 0.6$          | <b>B1</b>    | One variance stated unsimplified   |
|          | Variances same  | <b>B1</b>    | Second variance stated unsimplified<br><b>and</b> at least one variance clearly identified,<br><b>and</b> both evaluated <i>or</i> showing equal <i>or</i> conclusion made<br><br>SR <b>B1</b> – Standard Deviation calculated<br>Fulfil all the criteria for the variance method but calculated to Standard Deviation |
|          | <b>Total:</b>   | <b>2</b>     |  |

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|----------|--|------------------------|---|
| 7(iv)    | $1 - P(0, 1)$<br>$= 1 - [(0.6)^{10} + {}^{10}C_1(0.4)(0.6)^9] = 1 - 0.0464$<br>OR<br>$P(2,3,4,5,6,7,8,9,10)$<br>$= {}^{10}C_2(0.4)^2(0.6)^8 + \dots + {}^{10}C_9(0.4)^9(0.6) + (0.4)^{10}$ | <b>M1</b><br><b>M1</b> | Bin term ${}^{10}C_x p^x (1-p)^{10-x}$ $0 < p < 1$<br>Correct unsimplified answer |
|          | = 0.954  | <b>A1</b>              |   |
|          | <b>Total:</b>  | <b>3</b>               |   |