**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

# MARK SCHEME for the May/June 2011 question paper

# for the guidance of teachers

## 9709 MATHEMATICS

**9709/62** Paper 6, maximum raw mark 50

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 must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with 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 √ 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.

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

AEF Any Equivalent Form (of answer is equally acceptable)

AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

BOD Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)

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

MR Misread

PA Premature Approximation (resulting in basically correct work that is insufficiently accurate)

SOS See Other Solution (the candidate makes a better attempt at the same question)

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**

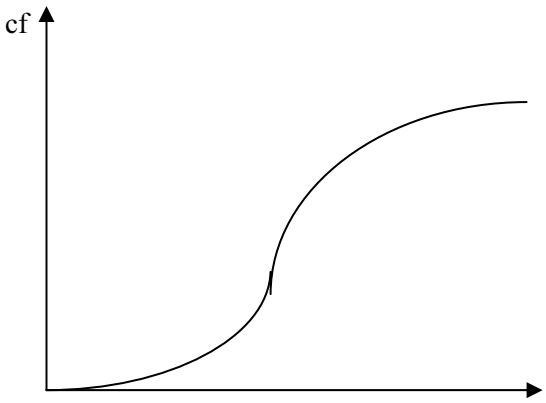
MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through √" marks. MR is not applied when the candidate misreads 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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| | | | |
|---|---|---|---|
| **1** | $20p = 4.8 \quad p = 0.24$ or $4.8/20$ | B1 | Correct value for $p$ |
| | $P(0, 1, 2) = (0.76)^{20} + {}^{20}C_1(0.24)^1(0.76)^{19}$ | M1 | Summing 2 or 3 binomial probs o.e., any $p$, $n = 5$ or 20 |
| | $+ {}^{20}C_2(0.25)^2(0.76)^{18}$ | A1 | Correct unsimplified answer |
| | $= 0.109$ | A1 **[4]** | Correct answer |
| | SR max 3 out of 4 | B1 | As above |
| | | M1 | Using N(4.8, 3.648) with cc 2.5 or 3.5 |
| | | A1 | 0.114 seen |
| **2** | **(i)** $np = 24$, $npq = 4.8$ | B1 | 24 and 4.8 or $\sqrt{4.8}$ seen can be unsimplified |
| | $z = \pm\left(\dfrac{24.5 - 24}{\sqrt{4.8}}\right) = 0.228$ | M1 | Standardising, need sq rt, cc not necessary |
| | | M1 | Continuity correction 24.5 or 25.5 used |
| | Prob = 0.590 | A1 **[4]** | Correct answer must be from 24.5 |
| | **(ii)** $np$ and $nq$ both $> 5$. | B1 **[1]** | Need both |
| **3** | **(i)** Mean $= 45 - 148/36 = 40.9$ or $1472/36$ | B1 | Correct answer |
| | *EITHER* | | |
| | Var $= 3089/36 - (-148/36)^2 = 68.9$ | M1 | $3089/36 - (\pm$ their coded mean$)^2$ |
| | sd $= 8.30$ | A1 **[3]** | Correct answer |
| | *OR* | | |
| | $\Sigma x^2 = 3089 - 36 \times 45^2 + 90 \times 1472 = 62669$ | M1 | Expanding $\Sigma(x - 45)^2$ with at least 2 terms correct and solving, then substituting their $\Sigma x^2$ in correct variance formula with their mean$^2$ subt numerically |
| | $\text{Var} = \left(\dfrac{62669}{36} - \left(\dfrac{1472}{36}\right)^2\right)$ | | |
| | sd $= 8.30$ | A1 | Correct answer |
| | **(ii)** New $\Sigma(x - 45) = -148 - 16 = -164$ | M1 | Adding their coded new value to $-148$ |
| | New $\Sigma(x - 45)^2 = 3089 + 16^2 = 3345$ | M1 | Adding their (coded value)$^2$ to 3089 |
| | New sd $= \sqrt{3345/37 - (-164/37)^2}$ | M1 | Subst in coded var formula, can have one of 29 and one of $-16$ here |
| | $= 8.41$ | A1 **[4]** | Correct answer |
| | *OR* $\Sigma x = 36 \times 45 - 148 = 1472$ | | |
| | New $\Sigma x = 1472 + 29 = 1501$ | M1 | Finding $\Sigma x$ and adding 29 |
| | $\Sigma x^2 = 3089 - 36 \times 45^2 + 90 \times 1472 = 62669$ | | |
| | New $\Sigma x^2 = 62669 + 29^2$ (= 63510) | M1 | Finding $\Sigma x^2$ and adding $29^2$, at least 2 terms of 3089, $36 \times 45^2$, $90 \times 1472$ |
| | New sd $= \sqrt{63510/37 - (1501/37)^2}$ | M1 | Subst their values in correct var formula |
| | $= 8.41$ | A1 | Correct answer |

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| **4 (i)** | 90720 | B1 **[1]** | Not 9!/2!2! |
| **(ii)** | 3 vowels together<br>$= 3! \times 7!/2!2! = 7560$ | B1<br>B1 | 3! oe seen multiplied by integer oe<br>7 or 6! seen multiplied as a num |
| | Prob(not together) $= \frac{90720 - 7560}{90720} = \frac{83160}{90720}$ | M1 | Subt from their **(i)** or dividing by their **(i)** or 1 – prob |
| | $= 0.917$ (=11/12) | A1 **[4]** | Correct answer from correct working |
| **(iii)** | One S in ${}^5C_3$ ways = 10<br>SS in ${}^5C_2$ ways = 10<br>Total = 20 | M1<br>M1<br>A1 **[3]** | ${}^5C_3$ seen added<br>${}^5C_2$ seen added<br>Correct answer |
| | *OR* ${}^6C_3$ | M1<br>M1 | ${}^6C_3 \times 2$ or $\div 2$ or $\times 1$ seen<br>${}^6C_3$ only |
| | $= 20$ | A1 | Correct answer |
| **5 (i)** | cf<br><br>Number of rooms | M1<br><br>M1<br><br>M1<br><br><br><br>A1 **[4]** | Attempt at cf table (up to 200)<br><br>Linear scale minimum 0 to 200 and 20 to 80, and labels<br><br>Attempt to plot points at (20.5, 10), (40.5, 42), (50.5, 104), (60.5, 154), (70.5, 182), (90.5, 200), accept (20, 10), (40, 42) or (21, 10), (41, 42) etc<br><br>All points correct and joined up, allow (0, 0) or (0.5, 0) |
| **(ii)** | Line on graph up from 30<br><br>$200 - 20 = 180$<br><br>*OR* using lin int $10 + \frac{(30 - 20.5)}{20} \times 32 = 25.2$<br><br>$= 174.8$ | M1<br><br>A1 **[2]**<br><br>M1<br><br>A1 | Line or mark seen, can be implied if matches graph and in range<br><br>Accept 174 – 180 if reading from graph<br><br>Can have 20 or 20.5<br><br>Accept decimals, 174 – 175 if using lin int |
| **(iii)** | Line on graph across from 150<br><br>59 rooms<br><br>*OR* lin int $50.5 + 46/50 \times 10$<br>$= 59$ or 60 | M1<br><br>A1 **[2]**<br><br>M1<br>A1 | Line or mark seen, can be implied if matches graph and in range. 150 seen and line between 140 and 160<br><br>Accept 58 – 60<br><br>Can have 50 or 50.5<br>Must be integer |

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|---|---|---|---|
| **6** **(i)** | $z = -1.282$ | B1 | $\pm 1.282$ or $\pm 1.281$ seen |
| | $P(x < 20) = P\left(z < \frac{20-\mu}{0.8}\right)$ | M1 | Standardising, no cc, must have 0.8, must be a $z$-value |
| | $-1.282 = \frac{20-\mu}{0.8}$ | | |
| | $\mu = 21.0$ cm (21.0256) | A1 **[3]** | Correct answer |
| **(ii)** | $P(21.5 < x < 22.5)$ | | |
| | $= P\left(\frac{21.5-21.03}{0.8}\right) < z < \left(\frac{22.5-21.03}{0.8}\right)$ | M1 | 2 attempts at standardising with their mean, must have 0.8 oe |
| | $= \Phi(1.8375) - \Phi(0.5875)$ | M1 | Subtracting 2 $\Phi$s ft their mean |
| | $= 0.9670 - 0.7217$ | | |
| | $= 0.2453$ | A1 | Needn't be entirely accurate, rounding to 0.24 or 0.25 |
| | $P(< 2) = P(0) + P(1)$ | | |
| | $= (0.7547)^4 + (0.2453)^1(0.7547)^3\ {}^4C_1$ | M1 | Binomial term with ${}^4C_r p^r (1-p)^{4-r}$ seen $r \neq 0$, any $p < 1$ |
| | | M1 | Bin expression for P(0) + P(1), any $p < 1$ |
| | $= 0.746$ | A1 **[6]** | Accept 3sf rounding to 0.75 |
| **7** **(i)** | $P(6) = P(3, 9) + P(9, 3) = 2/25 = 0.08$ AG | B1 **[1]** | Accept 2/25 seen |
| **(ii)** | | | |

| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Prob | 0.2 | 0.24 | 0.08 | 0.08 | 0.16 | 0.16 | 0.08 |

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|---|---|---|
| | M1 | Values 0 – 6 seen could be in list |
| | A1 **[2]** | All correct |
| **(iii)** Mean = $\Sigma xp = 2.56$ (64/25) | B1 **[1]** | |
| **(iv)** $P(4, 5, 6) = 0.4(10/25)$ or $0.16 + 0.16 + 0.08$ | B1 ft | ft their P(4, 5, 6) providing $p < 1$ |
| $= P(\text{draw}) \times 0.4$ | M1 | Multiplying by their P(draw) providing $p < 1$ |
| $= 0.2 \times 0.4 = 0.08$ (2/25) | A1ft **[3]** | Correct answer |
| **(v)** P(J wins on $n$th go) | M1 | Mult by any $p^n$ or $p^{n-1}$, $p < 1$ |
| $= (0.2)^{n-1} \times 0.4$ oe | A1ft **[2]** | ft their probs |

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