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MATHEMATICS **9709/61**

Paper 6 **May/June 2016**

MARK SCHEME

Maximum Mark: 50

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.

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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

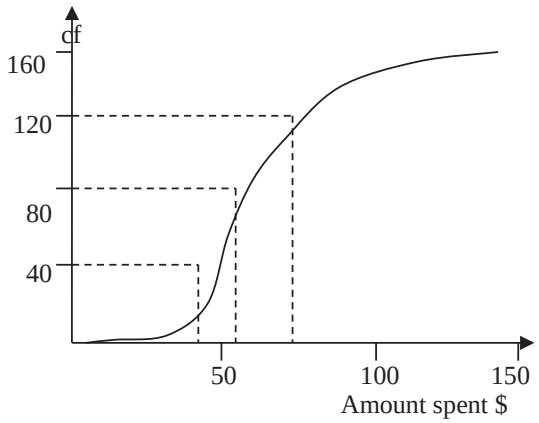
MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through √" marks. MR is not applied when the candidate misreads 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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Question	Answer	Marks	Guidance
1	$z = 1.037$ $1.037 = \frac{1.8-1.62}{\sigma}$ $\sigma = 0.18/1.037 = 0.174$	**B1** **M1** **A1** [3]	Rounding to 1.04 Standardising attempt allow cc no sq rt must have a z-value i.e. not 0.8023 or 0.5596.
2	P (throwing a 4) = (1 – 0.4) / 4 = 0.15 P(at most 1) = P(0, 1) or 1 – P(2, 3) $= (0.85)^3 + {}^3C_1\ (0.15)\ (0.85)^2$ = 0.939	**M1** **A1** **M1** **M1** **A1** [5]	Sensible attempt to find P(1) Correct answer A binomial term with ${}^3C_n$ oe any p Binomial expression with ${}^3C_n$ P(0, 1) or 1 – P(2, 3) $p = 0.15$ or 0.85
3 (i)	P (cup of coffee) = 0.6×0.9 + 0.4× 0.3 = 0.66	**M1** **A1** [2]	Summing two 2-factor probabilities Correct answer accept 0.660
(ii)	P(Not on time $\mid$ no cup of coffee) $= \frac{P(\text{not on time} \cap \text{no cup})}{P(\text{no cup})} = \frac{0.4\times 0.7}{1-0.66}$ $= \frac{0.28}{0.34} = 0.824$	**M1** **M1** **A1** [3]	0.4×0.7 seen as num or denom of a fraction Attempt at P(no cup) as $0.1\times p_1 + 0.7\times p_2$ or as 1 – (i) seen anywhere
4	[P(X = 0)] = P(B, B) = 5/7×4/6 = 10/21 [P(X = 1)] = P(G,B) + P(B,G) = 2/7×5/6 ×2 = 10/21 [P(X = 2] = P(G, G) = 2/7×1/6 = 1/21 E(X) = 0 + 10/21 + 2/21 = 4/7 (0.571) Var(X) = 0 + 10/21 + 4/21 – $(4/7)^2$ = 50/147 (0.340)	**M1** **A1** **A1** **B1**√ **M1** **A1** [6]	Attempt to find P(0) or P(1) or P(2) can be seen as P(BB) etc. or table unsimplified P(1) or P(BG)+P(GB) correct P(0) or P(2) correct must see X value Correct answer ft their probs P(1) and P(2) Attempt at $\Sigma x^2 p - [\mathrm{E}(X)]^2$
5 (i)	$P(x < 3.0) = P\left(z < \frac{3.0-2.6}{0.25}\right)$ + P(z < 1.6) = 0.945	**M1** **M1** **A1** [3]	Standardising no sq rt no cc Correct area i.e. prob > 0.5 legit
(ii)	X~B(500, 0.9452) ~ N(472.6, 25.898) $P\left(z > \frac{479.5-472.6}{\sqrt{25.89848}}\right) = P\ (z > 1.3558)$ = 1 – 0.9125 = 0.0875	**M1** **M1** **M1** **M1** **A1** [5]	500 ×'0.9452' and 500×'0.9452'×('1 – 0.9452') seen oe Standardising must have sq rt. All M marks indep cc either 479.5 or 480.5 seen correct area i.e. < 0.5

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Question	Answer	Marks	Guidance
(iii)	500× 0.9452 and 500× (1–0.9452) are both > 5	B1√ [1]	must see at least 500× 0.0548 > 5oe ft their (i) accept $np > 5$, $nq > 5$ if both not $npq > 5$
6 (a) (i)	9 × 9 × 8 = 648 OR 900 – 28 × 9 = 648	M1 M1 A1 [3]	Logical listing attempt
(ii)	(7….in 1 × 8 × 4 = 32 ways 8 …in 1 × 8 × 5 = 40 9… in 1 × 8 × 4 = 32 Total 104 ways	M1 M1 M1 A1 [4]	Listing #s starting with 7 or 9 and ending odd
(b)	R(6) T(5) D(4) 2 2 3 = ${}^6C_2\times{}^5C_2\times{}^4C_3 = 600$ 2 3 2 = ${}^6C_2\times{}^5C_3\times{}^4C_2 = 900$ 3 2 2 = ${}^6C_3\times{}^5C_2\times{}^4C_2 = 1200$ Total = 2700	 M1 M1 A1 A1 [4]	Mult 3 combs, ${}^6C_x\times{}^5C_y\times{}^4C_z$ Summing 2 or 3 three-factor outcomes can be perms, + instead of × 2 options correct unsimplified
7 (i)	cf 16, 56, 104, 130, 160  	M1 B1 M1 A1 [4]	Attempt at cf table (up to 160) no graph needed accept %cf but give final linear scale minimum 0 to 160 and 0 to 120 Attempt to plot points at (30, 16), (50, 56), (70,104), (90, 130), (140, 160) up to 2 errors can have a polygon All points correct from their scale and joined up, with (0,0) as well
(ii)	median $59 IQR = 82 – 43 = $39	B1√ M1 A1√ [3]	accept 57–60 or ft their graph if used lb, midpts instead of ub or assume linear interpolation. Subt a (sensible) LQ from a sensible UQ (generous) Ans ft need a cf graph and UQ 80–84, LQ

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Question	Answer	Marks	Guidance
(iii)	160 – 149 = 11 OR 115 is mid pt of last interval so # of shoppers is 30/2 = 15 (can be implied)	**M1** **A1** [2]	41–46 Subtracting from 160 can be implied Correct answer accept 9–16
(iv)	mean = (15×16+ 40×40 +60×48+ 80×26 + 115×30)/160 = 10250/160 = \$64.1= \$64.1	**M1** **A1** [2]	Using $\Sigma xf/160$ with mid-points

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