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MATHEMATICS **9709/62**

Paper 6 **May/June 2017**

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 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.

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

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

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

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

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Question	Answer	Marks	Guidance
	OR1: Route 2 *A***********A* in $^{9}C_{5} \times {}^{4}C_{2} = 756$ ways	**(M1**	*Considering AA and BB options* with values
	*B***********B* in $^{9}C_{4} \times {}^{5}C_{5} = 126$ ways	**A1**	Any one option correct
	756 + 126	**DM1**	*Summing their AA and BB outcomes* only
	Total = 882	**A1)**	
	Total:	**4**	

Question	Answer	Marks	Guidance
6(ii)	*EITHER:* (The subtraction method) *A*s together, no restrictions 8! / 2!5! = 168	**(*M1**	*Considering all As together* – 8! seen alone or as numerator – condone × 4! for thinking A's not identical
	*A*s together and *B*s 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 **first M** being awarded)
	= 126	**A1)**	
	OR1: *A*s together, no restrictions $^{8}C_{5} \times {}^{3}C_{1} = 168$	**(*M1**	$^{8}C_{5}$ seen alone or multiplied
		M1	$^{7}C_{5}$ seen alone or multiplied
	*A*s together and *B*s together $^{7}C_{5} \times {}^{2}C_{1} = 42$	**M1**	First expression x $^{3}C_{1}$ or second expression x $^{2}C_{1}$
	Total 168 – 42	**DM1**	Subt their 42 from their 168 (dependent upon **first M** being awarded)
	= 126	**A1)**	
	OR2: (The intersperse method)	**(M1**	*Considering all "As together" with Cs* – Mult by 6!
	(*AAAA)CCCCC* 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 –

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

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Question	Answer	Marks	Guidance
7(iv)	$1 - P(0, 1)$ $= 1 - [(0.6)^{10} + {}^{10}C_1(0.4)(0.6)^9] = 1 - 0.0464$ OR $P(2,3,4,5,6,7,8,9,10)$ $= {}^{10}C_2(0.4)^2(0.6)^8 + \ldots + {}^{10}C_9(0.4)^9(0.6) + (0.4)^{10}$	**M1** **M1**	Bin term ${}^{10}C_x p^x(1-p)^{10-x}$ $0 < p < 1$ Correct unsimplified answer
	$= 0.954$	**A1**	
	Total:	**3**	