

MARK SCHEME for the October/November 2012 series

9709 MATHEMATICS

9709/63

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 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.

Cambridge is publishing the mark schemes for the October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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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	$z = -1.036 = \frac{5.6 - 93}{\sigma}$ $\sigma = 3.57$	B1 M1 A1 3	$\pm (1.036 \text{ to } 1.037)$ seen Equation with 5.6 or 13.0, 9.3, σ and a z value, no cc Correct final answer
2	$-3p + 2r + 4 \times 0.4 = 2.3$ $(-3)^2 p + 2^2 r + 4^2 \times 0.4 - 2.3^2 = 3.01$ $p + q + r + 0.4 = 1$ $-3p + 2r = 0.7$ $9p + 4r = 1.9$ so $-9p + 6r = 2.1$ or $-6p + 4r = 1.4$ $4r + 6r = 1.9 + 2.1$ or $9p + 6p = 1.9 - 1.4$ $r = \frac{2}{5} (0.4), p = \frac{1}{30} (0.0333)$ $q = 0.6 - 0.4 - 0.0333 = \frac{1}{6} (0.167)$	B1 B1 B1 M1 A1 A1 6	Correct unsimplified equation, oe Correct unsimplified equation, oe Correct equation, oe Obtain an equation in 1 unknown One correct answer Remaining two answers correct
3	(i) $\frac{74}{170} \left(\frac{37}{85} \right) (0.435)$	B1 1	Correct answer
	(ii) $\frac{38}{96} \left(\frac{19}{49} \right) (0.396)$	B1 B1 2	Correct unsimplified numerator or denominator Correct answer
	(iii) P(high GDP and high birth rate) = 0 So they are exclusive	B1* B1dep* 2	Correct reason Correct answer, CWO
	(iv) $\frac{42}{74} \times \frac{41}{54}$ $= \frac{1722}{3996} \left(\frac{287}{666} \right) (0.431)$	M1 B1 A1 3	Multiplying 2 probabilities with different numerators and denominators, only One correct probability seen Correct answer
4	(i) $(3 \times 59 + 8 \times 67 + 15.5 \times 38 + 25.5 \times 18 + 40.5 \times 11) / 193$ $= 11.4$ $\sigma^2 = (3^2 \times 59 + 8^2 \times 67 + \dots) / 193 - (11.43..)^2$ $\sigma = 9.78 \text{ or } 9.79$	M1 A1 M1 A1 4	Attempt to calculate the mean using midpoints not ends, with frequencies, can be implied Correct mean Using $\Sigma x^2 f$ with mean ² subtracted numerically, can be implied Correct answer, method marks can be implied

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<p>(ii) fd = 11.8, 13.4, 3.8, 1.8, 0.55</p>	M1	Attempt at frequency density or scaling
	A1	Correct heights seen on graph
	B1	Bar lines correctly located at 5.5, 10.5, 20.5 and 30.5, no gaps, their scale which may be non-linear
	B1	correct widths of bars, independent of bar lines
	B1 5	Both axes uniform, from at least 0 to 14 if fd and 0.5 to 50.5, and labelled (fd or freq per 5% and % meat or % of meat)
<p>5 (i) $\Phi\left(\frac{84.5-82}{\sqrt{126}}\right) - \Phi\left(\frac{83.5-82}{\sqrt{126}}\right)$ $= \Phi(0.2227) - \Phi(0.1336)$ $= 0.5883 - 0.5533$ $= 0.0350$</p>	M1	Standardising using 83.5 or 84.5, must have square root
	M1	Subtracting two probabilities, both > 0.5 or both < 0.5
	A1 3	Correct answer
	M1	Standardising, no cc, must have square root
	A1	Correct probability
<p>(ii) $P(x > 87) = 1 - \Phi\left(\frac{87-82}{\sqrt{126}}\right) = 1 - \Phi(0.445)$ $= 1 - 0.6718 = 0.3282$ $P(0, 1) = (0.6718)^5 + {}_5C_1(0.3282)(0.6718)^4$ $= 0.471$</p>	M1	Standardising, no cc, must have square root
	A1	Correct probability
	M1	Any binomial term of form ${}_nC_x p^x (1-p)^{n-x}, x \neq 0$
	A1 4	Correct answer
	M1	Finding $P(x < 87)$, value > 0.5
<p>(iii) $P(x < 87) = 0.6718$ $P(x < k) = 0.9718$ $z = 1.908$ or 1.909 $1.909 = \pm \frac{k-82}{\sqrt{126}}$ $k = 103$</p>	M1	Adding 0.3 to their 0.6718 or equivalent
	A1	Correct z
	M1	Equation with k , 82 or 81.5 or 82.5, $\sqrt{126}$, and a z-value
	A1 5	Correct answer rounding to 103
	M1	
<p>6 (a) twins in: ${}_6C_2$ twins out: ${}_5C_2 \times {}_6C_2$ Total = 15 + 150 = 165 OR all: ${}_7C_2 \times {}_6C_2$ one twin: $2 \times {}_5C_1 \times {}_6C_2$ Total = 315 - 150 = 165</p>	B1	${}_6C_2$ alone or ${}_5C_2$ multiplied seen or implied
	M1	Summing two cases
	A1 3	Correct final answer
	B1	${}_7C_2 \times {}_6C_2$ alone or ${}_5C_1$ multiplied seen or implied
	M1	$2 \times {}_5C_1 \times {}_6C_2$ seen, subtracted
	A1	Correct final answer

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<p>(b)</p> <p>(i) ends in 2, 6 or 8: $6!/2!$ (= 360) ways</p> <p>ends in 4: $6!$ (= 720) ways</p> <p>Total = $3 \times 360 + 720$ = 1800 ways</p> <p>OR₁ all: $7!/2!$ (= 2520) ways</p> <p>ends in 1 or 7: $6!/2!$ (= 360) ways</p> <p>Total = $2520 - 2 \times 360$ = 1800</p> <p>OR₂ (4_A, 4_B) final digit: 5 ways</p> <p>other digits: $6!$ ways and \div by $2!$</p> <p>Total = 5×360 = 1800</p>	<p>B1</p> <p>B1</p> <p>M1</p> <p>A1 4</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p>	<p>Correct option for ending with 2 or 6 or 8. $6!/2!$ seen anywhere, not multiplied</p> <p>Correct option for ending in 4</p> <p>Summing 3 or 4 even options</p> <p>Correct final answer</p> <p>$7!/2!$ seen anywhere, not multiplied</p> <p>$6!/2!$ seen, subtracted</p> <p>Subtract 2 odd options from total options</p> <p>Correct final answer</p> <p>5 seen, multiplied</p> <p>$6!$ seen and divide by $2!$ at some stage</p> <p>Multiplying their two numbers</p> <p>Correct final answer</p>
<p>(ii) $5 \times 4 \times 3 \times 2$ or ${}_5P_4$ or ${}_5C_4 \times 4!$ or $5!$ or ${}_5P_5$ or ${}_6P_5 \div 6$</p> <p>= 120 ways</p>	<p>M1</p> <p>A1 2</p>	<p>One of these oe</p> <p>Correct final answer</p>
<p>(c) $\left(\frac{2}{3}\right)^7$</p> <p>= $\frac{128}{2187}$ (0.0585)</p>	<p>M1</p> <p>M1</p> <p>A1 3</p>	<p>$2/3$ seen multiplied</p> <p>7 probabilities multiplied together</p> <p>Correct final answer</p>