

MARK SCHEME for the May/June 2010 question paper
for the guidance of teachers

9709 MATHEMATICS

9709/71

Paper 71, 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.

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	GCE AS/A LEVEL – May/June 2010	9709	71

Mark Scheme Notes

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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.

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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 $\surd$ 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.

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AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
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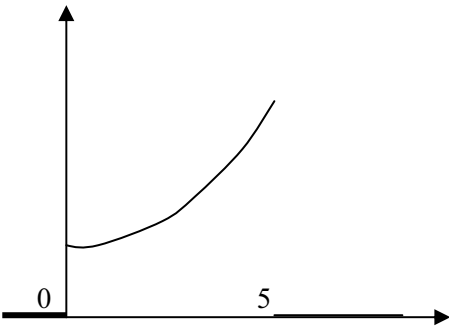
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1 (i) 1/12	B1 [1]	Accept 0.0833
(ii) trains arrive every 12 minutes	B1 [1]	must have 'every 12 minutes'
2 (i) 0.145 = 87 / n n = 600	B1 M1 A1 [3]	correct mid-point equating their mid-point with 87 / n correct answer
(ii) $0.0321 = z \times \sqrt{\frac{0.145(1-0.145)}{600}}$ $z = 2.233 \quad \Phi(z) = 0.9872$ width of CI is $1 - 2 \times (1 - 0.9872)$ $\alpha = 97.4\%$	B1 M1 M1 A1 [4]	0.0321 seen or implied Equating half-width with $z \times \sqrt{\frac{pq}{n}}$ Correct method to find width of CI Correct answer
3 (i) $z = \frac{2.55 - 2.62}{0.3/\sqrt{45}} = -1.565$ $P(z > -1.565) = 0.941$	M1 M1 A1 [3]	Standardising no cc Dividing 0.3 by $\sqrt{45}$ as denominator Correct answer (Accept equivalent method using totals)
(ii) rejection region is $m < a_1$ and $m > a_2$ where $\frac{a_1 - 2.62}{0.3/\sqrt{30}} = -1.645$ and $\frac{a_2 - 2.62}{0.3/\sqrt{30}} = 1.645$ $m < 2.53$ and $m > 2.71$	B1 M1 M1 A1 [4]	± 1.645 seen one correct unsimplified equation of correct form second unsimplified equation of correct form (or clear use of 1-tail test and ± 1.282 used) correct answer

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4 (i) $Mr - 5Mrs \sim N(512 - 5 \times 89, 62^2 + 25 \times 7.4^2)$ $\sim N(67, 5213)$ $P(Mr > 5 Mrs) = P(Mr - 5 Mrs > 0)$ $= P\left(z > \frac{0 - 67}{\sqrt{5213}}\right)$ $= P(z > -0.9280)$ $= 0.823$	B1 B1 M1 M1 A1 [5]	Correct unsimplified mean Correct unsimplified variance Using distribution $Mr - 5 Mrs$ Standardising and using tables Correct answer
(ii) $Mr + Mrs \sim N(601, 62^2 + 7.4^2)$ $E[5/8(Mr + Mrs)] = 376 \text{ miles}$ $\text{Var}[5/8(Mr + Mrs)] = \frac{25}{64} \times 3898.76$ $= 1520$ $\text{sd} = 39.0 \text{ miles}$	B1 B1 B1 [3]	Correct mean and variance Correct answer SR Two separate answers 320 and 55.6 B1 Correct answer
5 (i) $\int_0^5 ke^{0.2t} dt = 1$ $\left[\frac{k}{0.2} e^{1.0} \right] - \left[\frac{k}{0.2} e^0 \right] = 1$ $\frac{k}{0.2} (e - 1) = 1$ $k = \frac{1}{5(e - 1)} \text{ AG}$	M1 A1 A1 [3]	Equating to 1 and attempting to integrate Correct integrand and limits Correct answer legitimately obtained
(ii) 	B1 B1 [2]	Correct curve shape Correct horizontal lines (need to see a 5)
(iii) $\int_0^T ke^{0.2t} dt = 0.2$ $\left[5ke^{0.2T} \right] - [5k] = 0.2$ $e^{0.2T} = \frac{0.2}{5k} + 1 = 1.344$ $T = 1.48 \text{ (seconds)}$	M1 A1 A1 [3]	Equation relating T and 0.2 or 0.8 Correct equation (can be in 'k') Correct answer

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6 (i) $\lambda_A = np = 0.022 \times 55 = 1.21$ $\lambda_B = 0.058 \times 55 = 3.19$ total $\lambda = 4.4$ $P(\text{more than } 2) = 1 - P(0, 1, 2)$ $= 1 - e^{-4.4} \left(1 + 4.4 + \frac{4.4^2}{2!} \right)$ $= 1 - 0.185$ $= 0.815$	M1 A1 M1 A1 [4]	Two different np (can be implied) Correct total 4.4 (or alt method: 6 correct combinations 0,0 1,0 etc stated and used) Finding $1 - P(0, 1, 2)$, Poisson, any mean, allow one end error. (Or combinations method – <i>use</i> at least 4 and find $1 - P(\leq 2)$) Correct answer
(ii) $\lambda = 0.08n$ $P(\text{at least 1 stained tablecloth}) = 1 - P(0)$ $1 - e^{-0.08n} > 0.99$ $0.01 > e^{-0.08n}$ $n > 57.6$ least value of $n = 58$	B1 M1 M1 A1 [4]	Correct λ Equation of correct form relating their λ and 0.99 Valid attempt to solve equation of correct form by logs or trial and error Correct answer (SR Accept use of Binomial leading to $n = 57$)
7 (i) Type I error is made when we say the number of white blood cells has decreased when it hasn't. $P(0) = e^{-5.2} = 0.005516$ $P(1) = e^{-5.2}(5.2) = 0.02868 \Sigma < 0.10$ $P(2) = e^{-5.2}(5.2^2/2) = 0.07458 \Sigma > 0.10$ $P(\text{Type I error}) = 0.0342$	B1 M1 M1* A1dep [4]	Correct and relating to question Evaluating at least 2 of $P(X = 0, 1, 2)$ Comparing their Σ 3 probs with 10% (must be Σ probs) Correct answer, dep on previous M
(ii) $H_0: \lambda = 5.2$ $H_1: \lambda < 5.2$ $P(0+1+2) = 0.1087 > 10\%$ 2 not in C Region. Accept H_0. Not enough evidence to say the number of blood cells has decreased.	B1 M1 A1 [3]	Both hypotheses correct Stating 2 is not in the critical region from above, or evaluating $P(0, 1, 2)$ and comparing with 10% again Correct conclusion no contradictions
(iii) $P(\text{Type II error}) = 1 - P(0, 1)$ $= 1 - e^{-4.1}(1 + 4.1)$ $= 0.915$	B1 M1 A1 [3]	Identifying correct area (indep) Some form of (Poisson) expression with mean 4.1 Correct answer

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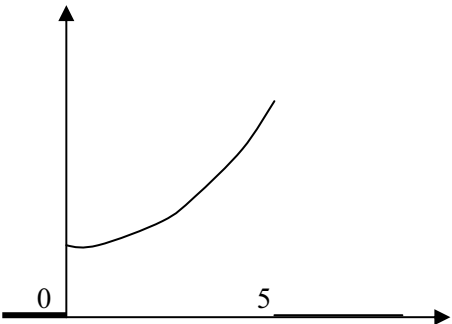
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1 H_0: Pop prop = $\frac{1}{3}$ (or unchanged) H_1: Pop prop < $\frac{1}{3}$ (or decreased) $(\frac{2}{3})^{20} + 30(\frac{2}{3})^{19}(\frac{1}{3}) + {}^{20}C_2(\frac{2}{3})^{18}(\frac{1}{3})^2$ $+ {}^{20}C_3(\frac{2}{3})^{17}(\frac{1}{3})^3$ $= 0.0604/0.0605$ comp “0.0604” with 0.025 No evidence that support decreased or support probably not decreased SC Use Of Normal Standardising with or without cc Obtains $z = -1.502$ Valid Comparison with $z = -1.96$ Correct conclusion	B1 M1 A1 M1 A1ft [5] M1 A1 M1 A1ft	Accept p Attempt Bin(20, $\frac{1}{3}$) $P(\leq 3)$ Allow one term omitted For comparison of their 0.0604 Correct conclusion no contradictions
2 (i) 2-tail; $H_1: \mu \neq 35$	B1 [1]	
(ii) comp -1.75 with -1.645 (or 1.75 with 1.645) Evidence that μ is not 35 or reject $\mu = 35$	M1 A1 [2]	Allow “Accept $\mu \neq 35$”. No contradictions
(iii) 8	B2 [2]	SR B1 for 4, 8.02, or 92%
3 (i) (Approx) normal mean 62 $sd = \frac{8.2}{\sqrt{50}} = 1.16$ (3 sfs)	B1 B1 B1 [3]	or var = $\frac{8.2^2}{50} = 1.34$ (3 sfs)
(ii) $\frac{64-62}{1.16}$ (= 1.725 or 1.724) $1 - \Phi(“1.725”)$ $= (1 - 0.9577)$ $= 0.0423$ (3 sfs)	M1 M1 A1 [3]	For standardising $\div \sqrt{50}$ essential (no CC) For correct area consistent with their mean

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4	(i) Mean is 4.8 but ≤ 1 breakdown	B1 [1]	Accept reduction when none has occurred
	(ii) $e^{-4.8}(1 + 4.8)$ $= 0.0477$	M1 A1 [2]	Poisson attempt at P(0) (+ P(1))
	(iii) $P(X > 1)$ $= 1 - e^{-0.9}(1 + 0.9)$ $= 0.228$ (3 sfs)	M1 M1 A1 [3]	Attempt correct probability for Type II error Allow any λ except 4.8; $1 - (P(0) + P(1))$ using Poisson As final answer
5	(i) $\int_1^{\infty} \frac{k}{x^4} dx = 1$ $\left[-\frac{k}{3x^3} \right]_1^{\infty} = 1$ oe $(0 + \frac{k}{3} = 1 \Rightarrow k = 3 \text{ AG})$	M1 A1 [2]	Attempt integ $f(x)$ & “= 1”; ignore limits Correct integrand & limits leading to AG, no errors seen
	(ii) $\int_1^{\infty} x \times \frac{3}{x^4} dx$ $\left[-\frac{3}{2x^2} \right]_1^{\infty}$ $= \frac{3}{2}$ $\int_1^{\infty} x^2 \times \frac{3}{x^4} dx$ $\left[-\frac{3}{x} \right]_1^{\infty} (= 3)$ “3” – $\left(\frac{3}{2} \right)^2$ $= \frac{3}{4}$	M1 A1 M1* A1 M1*dep A1 [6]	Attempt integ $xf(x)$; ignore limits. CWO Attempt integ $x^2f(x)$; ignore limits. Correct integrand; correct limits dep 2 nd M1 attempt $E(X^2) - [E(X)]^2$ cwo

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6	(i)	$5 \times (22.4 + 20.3)$ & $5 \times (4.8^2 + 5.2^2)$ $z = \frac{180 - "213.5"}{\sqrt{"250.4"}} (= -2.117)$ $1 - \Phi(" -2.117") = \Phi("2.117")$ $= 0.983$ (3 sfs)	(= 213.5) (= 250.4)	B1 B1 M1 A1 [4]	For correct expression for new mean For correct expression for new variance Standardising and use of tables (no sd/var mixes + no cc)
		(ii)	$P(H - W > 0)$ $20.3 - 22.4$ & $4.8^2 + 5.2^2$ $z = \frac{0 - (-2.1)}{\sqrt{"50.08"}} (= 0.297)$ $1 - \Phi("0.297")$ $(= 1 - 0.6168)$ $= 0.383$ (3 sfs)	(= -2.1) (= 50.08)	M1 B1 B1 M1 A1 [5]
7	(i)	Patients arrive at constant mean rate Patients arrive at random Patients arrive independently Patients arrive singly		B1 B1 [2]	B1 For first correct B1 For second correct Must be in context SR B1 For two correct but not in context
	(ii) (a)	$1 - e^{-4.2}$ $= 0.985$		M1 A1 [2]	Correct expression
	(b)	$4.2 \times {}^{10}/_{15} \text{ oe}$ $e^{-2.8} \times (1 + 2.8 + \frac{2.8^2}{2!} + \frac{2.8^3}{3!})$ $= 0.692$		B1 M1 A1 [3]	Allow extra term $e^{-2.8} \times \frac{2.8^4}{4!}$ Allow incorrect λ (not 4.2)
	(iii)	$N(336, 336)$ stated or implied $\frac{370.5 - 336}{\sqrt{336}} (= 1.882)$ $1 - \Phi("1.882")$ $= 0.0300/0.0299$		B1 M1 M1 A1 [4]	ft "336" Allow wrong or no cc or no $\sqrt$ Standardising with correct cc and no $\sqrt$ Allow 0.03