MARK SCHEME for the October/November 2006 question paper

9709 MATHEMATICS

9709/07   Paper 7, maximum raw mark 50

This mark scheme is published as an aid to teachers and students, 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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

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 $\sqrt{}$ 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 $\sqrt{}$" 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.

1 (i) H_0: $\mu = 46$ H_1: $\mu \neq 46$	B1	**1**	Both correct
(ii) critical value $z = \pm 1.96$ no significant difference in times	M1 A1	 **2**	For $z = +1.96$ or -1.96 and some comparison seen OR for 0.0419 compared with 0.025 o.e. For correct comparison and correct conclusion (SR For one tail test in (i) allow M1 for z=+/-1.645 or comparison 0.0419 with 0.05 o.e.)
2 (i) mean μ variance σ^2/n	B1 B1	 **2**	
(ii) normal	B1	**1**	
(iii) unknown, or normal if the pop is normal	B1	**1**	Accept either
3 (i) $p = 203/278$ (= 0.7302= 0.73) $0.7302 \pm 2.17 \times \dfrac{\sqrt{(0.7302 \times 0.2698)}}{\sqrt{278}}$ = (0.672, 0.788)	B1 M1 B1 A1	 **4**	Correct p Correct form $p \pm z \times \sqrt{\dfrac{pq}{n}}$ either/both sides Correct z Correct answer
(ii) mainly unemployed, retired, or mothers with children ie not representative of whole pop	B1	**1**	Or any sensible equivalent
4 (i) $\lambda_1 = 3.6$ $\lambda_2 = 4.2$ $P(3) = e^{-7.8} \times 7.8^3 / 3!$ $= 0.0324$	M1 M1 A1	 **3**	Attempt at using Poisson with a different mean An attempt at P(3) using their 7.8 Correct answer
(ii) $\lambda = 64 \times 6 = 384$ $X \sim N(384, 384)$ $P(X<369) = \Phi\left(\dfrac{368.5 - 384}{\sqrt{384}}\right)$ $= \Phi(-0.791)$ $= 1 - 0.7855$ $= 0.215$	 M1 M1 B1 A1	 **4**	Their variance = their mean (with attempt at 384) Standardising, with or without cc Correct cc within a std expression Correct answer, accept 0.214 (cwo)

5 (i) $R - (C_1 + C_2) \sim N\,(27.4,\ 228.5)$ or vv	B1 B1		Correct mean (accept un-simplified form) Correct variance (accept un-simplified form)
$P\{(R - (C_1 + C_2)) < 0\} = \Phi\left(\dfrac{0 - 27.4}{\sqrt{228.5}}\right)$	M1		Considering $P\{(R - (C_1 + C_2)) < 0\}$ o.e.
$= 1 - \Phi\,(1.813)$ $= 0.0349$	M1 A1	5	Standardising and finding correct area ie < 0.5 Correct answer
(ii) Mean = 99.5(99.45)	B1		Correct mean
Variance = $1.5^2 \times 7.1^2$	M1		Variance involving 1.5^2
$= 113.4\ (= 113)$	A1	3	Correct variance (SR var=$7.1^2 + (1/2)^2 (7.1)^2$ scores M1)
(iii) $P(1.5C > 87) = 1 - \Phi\left(\dfrac{87 - 99.45}{\sqrt{113.4}}\right)$	M1		Standardising and finding correct area ie > 0.5
$= 1 - \Phi(-1.169)$ $= \Phi\,(1.169)$ $= 0.879$	A1	2	Correct answer
6 (i) $H_0: \lambda = 2.4$ $H_1: \lambda > 2.4$ (or 0.8 per hectare)	B1		For both H_0 and H_1
Under H_0 $P(X \geq 5) = 1 - P(0,1,2,3,4)$	M1*		For recognisable Poisson expression, any mean
$= 1 - e^{-2.4}(1 + 2.4 + 2.4^2/2 + 2.4^3/6 + 2.4^4/24)$	M1*$_{dep}$		For evaluating $P(X \geq 5)$ or finding critical region
$= 1 - 0.904$ $= 0.0959$	A1		For 0.0959 or 0.096 or critical region is $X \geq 5$
0.0959 is less than 0.10 so in critical region ploughing has increased number of metal pieces found	M1*		For comparing their $P(X \geq 5)$ with 10% or saying 5 is in critical region o.e.(o.e. comparison consistent with their H_1)
	A1ft	6	Correct conclusion, must relate to question, ft on their critical value or their $P(X \geq 5)$
(ii) no significant increase at the 5% level	B1ft*$_{dep}$ 1		
(iii) $P(X < 4) = e^{-4.2} \times (1 + 4.2 + 4.2^2/2 + 4.2^3/6)$	M1*		Using $\lambda = 4.2$ (or 1.4) in a Poisson expression
$= 0.395$	M1*$_{dep}$ A1	3	Finding $P(X < 4)$ Correct answer(as final answer)

7 (i) all cars stayed between 1 and 9 hours	B1	1	Or equivalent
(ii) $\int_1^9 kx^{-3/2}\, dx = 1$ $[-2kx^{-1/2}]_1^9 = 1$ $-2k/3 - -2k = 1$ $k = \frac{3}{4}$ AG	M1 A1	 2	Equating to 1 and attempting to integrate Correct answer, legitimately obtained
(iii)) $\int_1^9 0.75\, x^{-1/2}\, dx = [1.5 x^{1/2}]_1^9$ $= 4.5 - 1.5 = 3$ hours	M1 A1 A1	 3	Attempt to integrate $xf(x)$ Correct integral with correct limits Correct answer
(iv) $1 - e^{-x} > 0.75$ $0.25 > e^{-x}$ $x > 1.39$ hours (oe)	M1* M1dep* A1	 3	Equality or inequality involving e^{-x} and 0.75 Solving attempt by logs or trial and error For 1.39 no errors seen
(v) $P(X > 1.386) = \int_{1.386}^9 0.75\, x^{-3/2}\, dx$ $= [-1.5 x^{-1/2}]_{1.386}^9$ $= -0.5 - - 1.274$ $= 0.774$	 M1 A1	 2	 Attempting to integrate from their (iv) to 9, or from 1 to their (iv) Correct answer.(Accept 0.772)