
MATHEMATICS

9709/07

Paper 7

For examination from 2017

MARK SCHEME

Maximum Mark: 50

Specimen

This document consists of **9** printed pages and **1** blank page.

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 \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.

- 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 \checkmark ” 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.

Question	Answer	Marks	Partial Marks	Guidance
1	$\lambda = (1.2 + 2.3) \div 2$	1	M1	Attempt combined mean, allow 1.2 + 2.3
	$= 1.75$	1	A1	Correct mean
	$e^{-1.75} \left(\frac{1.75^2}{2} + \frac{1.75^3}{3!} \right)$	1	M1	Allow incorrect mean.
	$= 0.421$ (3 sf)	1	A1	Allow end errors (1 and/or 4)
		4		
2(i)	$\frac{6}{\sqrt{120}}$ oe seen	1	B1	Or $6^2/120$ oe seen
	$\frac{30 - 29}{\left(\frac{6}{\sqrt{120}} \right)}$ (= 1.826)	1	M1	\pm Allow without $\sqrt{120}$. No sd/var mix
	$P(z > '1.826') = 1 - \Phi('1.826')$	1	M1	Correct tail consistent with their working
	$= 0.034$ (2 sf)	1	A1	0.0339
		4		
2(ii)	No n is large (≥ 30)	1	B1	1 st B1 for either comment
	Sample mean is (appr) normally distrib or The CLT applies oe	1	B1	2 nd B1 for 'No' with 2 nd comment (No mark for 'No' alone)
		2		

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Question	Answer	Marks	Partial Marks	Guidance
3(i)	$\frac{3420}{60} (= 57)$	1	B1	
	$\frac{60 \left(\frac{195200}{60} - 57^2 \right)}{59} (= 4.40678)$	1	M1	Oe
	= 4.41 (3 sf)	1	A1	As final answer
		3		
3(ii)	$57 \pm z \sqrt{\frac{4.40678}{60}}$	1	M1	
	$z = 2.326$	1	B1	2.326 – 2.329 (accept 2.33 if no better seen)
	[56.4 to 57.6] (3 sf)	1	A1	NB: use of biased variance in (ii) can score in full
		3		
4(i)	$k \int_1^2 (3-x) dx = 1$	1	M1	Attempt $\int f(x) = 1$, ignore limits or $\frac{k}{2} (h_1 + h_2) = 1$
	$k \left[3x - \frac{x^2}{2} \right]_1^2 = 1$	1	A1	Correct integration & limits or $\frac{k}{2} (2 + 1) = 1$
	$(k(6 - 2 - (3 - 0.5)) = 1)$ $k \times 1.5 = 1$ or $k \times \frac{3}{2} = 1$ or $k = \frac{1}{1.5}$ oe $k = \frac{2}{3}$ AG	1	A1	No errors seen
		3		

Question	Answer	Marks	Partial Marks	Guidance
4(ii)	$\frac{2}{3} \int_1^m (3-x) dx = 0.5$ oe \int from m to 2	1	M1*	Attempt Int $f(x) = 0.5$, ignore limits oe Or use of area of trapezium
	$\left(\frac{2}{3} \left[3x - \frac{x^2}{2} \right]_1^m = 0.5 \right)$ $\frac{2}{3} \left[3m - \frac{m^2}{2} - 2.5 \right] = 0.5$	1	DM1	Sub of correct limits into their integral. Or trapezium using 1 and m/m and 2 Any correct 3-term QE = 0 or $(m-3)^2 = 2.5$
	$m^2 - 6m + 6.5 = 0$ oe	1	A1	
	$\left(m = \frac{6 \pm \sqrt{36 - 4 \times 6.5}}{2} = 1.42 \text{ or } 4.58 \right)$ $m = 1.42$ (3 sf)	1	A1	or $\frac{6 - \sqrt{10}}{2}$ oe; single correct ans
			4	
5(i)	Po(1.6) stated or implied	1	M1	
	$P(X > 3) = 1 - e^{-1.6} \left(1 + 1.6 + \frac{1.6^2}{2} + \frac{1.6^3}{3!} \right)$	1	M1	Allow M1 for $1 - P(X \leq 3)$, incorrect λ and allow one end error
	= 0.0788 (3 sf)	1	A1	SR Use of Bin scores B1 only for 0.0788
			3	

Question	Answer	Marks	Partial Marks	Guidance
5(ii)	$\lambda = \frac{n}{2500}$	1	B1	Alt method 1: $e^{-\mu} < 0.05$ M1 Alt method 2: $\frac{2499}{2500}$ B1
	$e^{-\frac{n}{2500}} < 0.05$ Allow = Allow incorrect λ	1	M1	Alt method 2: $\left(\frac{2499}{2500}\right)^n < 0.05$ M1
	$-\frac{n}{2500} < \ln 0.05$ Attempt ln bs $n > 7489.3$ (1 dp)	1	M1	Alt method 1: $-\mu < \ln 0.05$ ($\mu > 2.9957$) M1 Alt method 2: $n \ln \frac{2499}{2500} < \ln 0.05$ M1
	Smallest $n = 7490$	1	A1	Alt method 1: $n = \mu \times 2500$ Smallest $n = 7490$ A1 Alt method 2: Smallest $n = 7488$ A1
			4	
6(i)	$E(T) = 9 \times 78 + 7 \times 66$ (= 1164)	1	B1	Or $9 \times 78 + 7 \times 66 - 1200$
	$\text{Var}(T) = 9 \times 7^2 + 7 \times 5^2$ (= 616)	1	B1	
	$\frac{1200 - 1164}{\sqrt{616}}$ (= 1.450)	1	M1	\pm Allow without $\sqrt{\quad}$
	$P(z < 1.450) = \Phi(1.450)$	1	M1	
	= 0.927 (3 sf)	1	A1	Correct tail consistent with their mean
		5		

Question	Answer	Marks	Partial Marks	Guidance
6(ii)	$E(D) = 66 - 78$ (= -12)	1	B1	Both needed
	$\text{Var}(D) = 7^2 + 5^2$ (= 74)			
	$\frac{0 - (-12)}{\sqrt{74}}$ (= 1.395)	1	M1	± Allow without √
	$P(D > 0) = 1 - \Phi('1.395')$	1	M1	Correct tail consistent with their mean
	0.0815 (3 sf)	1	A1	Similar scheme for $P(M - W) < 0$
		4		
7(i)	Prob could be different later in day or on a different day oe	1	B1	or any explanation why not random or “Not random” or “Not representative”
7(ii)	Looking for decrease (or improvement)	1	B1	oe
	$H_0: P(\text{not arrive}) = 0.2$ $H_1: P(\text{not arrive}) < 0.2$	1	B1	Allow “ $p = 0.2$ ”
		2		
7(iii)	Concluding that prob has <u>decreased</u> (or publicity has worked) when it hasn't oe	1	B1	In context

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Question	Answer	Marks	Partial Marks	Guidance
7(iv)	$P(X = 0)$ and $P(X = 1)$ attempted	1	M1	B(30, 0.2) Not nec'y added May be implied by calc $P(X \leq 2)$ or $P(X \leq 3)$
	$P(X \leq 2) = 0.8^{30} + 30 \times 0.8^{29} \times 0.2 + {}^{30}C_2 \times 0.8^{28} \times 0.2^2$ (= 0.0442)	1	M1	Attempt $P(X \leq 2)$
	$P(X \leq 3) = 0.8^{30} + 30 \times 0.8^{29} \times 0.2 + {}^{30}C_2 \times 0.8^{28} \times 0.2^2 + {}^{30}C_3 \times 0.8^{27} \times 0.2^3$ = 0.123	1	B1	Or '0.0442' + ${}^{30}C_3 \times 0.8^{27} \times 0.2^3 = 0.123$
	cr is $X \leq 2$	1	A1	
	$P(\text{Type I}) = 0.0442$ (3 sf)	1	A1	
			5	
7(v)	3 is outside cr	1	M1	Comparison of 3 with their cr or $P(X \leq 3) = 0.123$ which is > 0.05
	No evidence that p has decreased (or that publicity has worked)	1	A1 ✓	Correct conclusion. No contradictions
			2	

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