
MATHEMATICS

9709/71

Paper 7

May/June 2019

MARK SCHEME

Maximum Mark: 50

Published

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This document consists of **10** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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.

Question	Answer	Marks	Guidance
1(i)	Mean = 115	B1	
	SD = 40	B1	
		2	
1(ii)	Mean = $15 \times '115' = 1725$	B1ft	
	$15 \times '40'^2$ (= 24000)	M1	or SD = $\sqrt{15 \times '40'}$. ft their (i)
	SD = $\sqrt{24000}$ SD = 155 (cents) (3 sf)	A1	Accept $\sqrt{24000}$ SC: Allow correct answers in dollars
		3	

Question	Answer	Marks	Guidance
2(i)	Assume sd still 4.8 or is unchanged	B1	or Assume the 150 times can be treated as a random sample / are independent
	H ₀ : Pop mean = 26.5 H ₁ : Pop mean > 26.5	B1	Allow ' μ ' but not just 'mean'
	$\frac{27.5-26.5}{\frac{4.8}{\sqrt{150}}}$	M1	Standardise, with $\sqrt{}$ Accept CV method
	= 2.552	A1	
	Comp with z-value '2.552' > 2.326	M1	or comp $1 - \Phi('2.552')$ with 0.01 $1 - 0.9946 = 0.0054 < 0.01$
	There is evidence time has increased	A1ft	oe No contradictions (2 tail test scores max. B1 B0 M1 A1 M1 (for comparison with 2.576) A0 no ft)
		6	

Question	Answer	Marks	Guidance
2(ii)	No because pop is normal so distr of $\bar{X}$ is normal	B1	Condone just ‘No because pop is normal’
		1	

Question	Answer	Marks	Guidance
3(i)	$H_0: P(6) = \frac{1}{6}$ $H_1: P(6) < \frac{1}{6}$	B1	
	$(\frac{5}{6})^{30} + 30(\frac{1}{6}) \times (\frac{5}{6})^{29} + {}^{30}C_2(\frac{1}{6})^2 \times (\frac{5}{6})^{28}$	M1	Allow one term incorrect, omitted or extra
	$= 0.103$	A1	
	‘0.103’ > 0.05	M1	
	No evidence (at 5% level) that die biased	A1ft	oe No contradictions
		5	
3(ii)	$(\frac{5}{6})^{30} + 30(\frac{1}{6}) \times (\frac{5}{6})^{29}$	M1	
	$P(\text{Type I}) = 0.0295$	A1	
		2	

Question	Answer	Marks	Guidance
4(a)(i)	$0.5 \times 1/a = (\frac{0.5}{a})$	M1	Or attempt to integrate $f(x)$ ($=1/a$) between 0 and 0.5
	$= \frac{1}{2a}$ oe	A1	Accept 0.5/a for A1
		2	
4(a)(ii)	$\frac{a}{2}$	B1	
		1	
4(a)(iii)	$\int_0^a \frac{x^2}{a} dx - (\frac{a}{2})^2$	M1	Integ their $x^2 f(x)$ from 0 to a and sub their mean ²
	$\text{Var}(X) = \frac{a^2}{3} - \frac{a^2}{4}$ ($\text{Var}(X) = \frac{a^2}{12}$ AG)	A1	Must see this line oe
		2	
4(b)	$\int_2^b \frac{3}{2(t-1)^2} dt$	M1	Attempt integ $g(t)$ ignore limits
	$\left[-\frac{3}{2(t-1)} \right]_2^b$	A1	Correct integral
	$-\frac{3}{2} \left(\frac{1}{(b-1)} - 1 \right) = \frac{3}{4}$ ($1 - \frac{1}{(b-1)} = \frac{1}{2}$)	M1	Attempt subst correct limits in their integ and $= \frac{3}{4}$
	$b = 3$	A1	
		4	

Question	Answer	Marks	Guidance
5(a)(i)	$e^{-2.3} \left(\frac{2.3^2}{2} + \frac{2.3^3}{3!} + \frac{2.3^4}{4!} \right)$	M1	Allow one end error
	$= 0.585$	A1	
		2	
5(a)(ii)	$(\lambda) = 4.6$	B1	
	$1 - e^{-4.6} \left(1 + 4.6 + \frac{4.6^2}{2} \right)$	M1	any λ , Allow one end error
	$= 0.837$ (3 sf)	A1	
		3	
5(a)(iii)	$S \sim N(115, 115)$	B1	May be implied
	$\frac{110.5-115}{\sqrt{115}} \quad (= -0.420)$	M1	Allow with wrong or no cc OR no $\sqrt{}$
	$1 - \Phi('0.420')$ $(= 1 - 0.663)$	M1	
	$= 0.337$	A1	Accept alternative method using $N(2.3, 2.3)$ no mixed methods.
		4	
5(b)	$e^{-\lambda} \times \frac{\lambda^3}{3!} = e^{-\lambda} \times \frac{\lambda^5}{5!}$	M1	
	$\lambda^3 = \frac{\lambda^5}{4 \times 5} \quad \text{or} \quad \lambda^2 = 20 \quad \text{oe}$	A1	any correct simplification without $e^{-\lambda}$ or $!$
	$\lambda = \sqrt{20}$ or $2\sqrt{5}$ or 4.47 (3 sf)	A1	
		3	

Question	Answer	Marks	Guidance
6(i)	Biased towards people who like tennis Excludes people who don't like tennis	B1	or other sensible
		1	
6(ii)	Obtain a list of all people in the town	B1	
	Use random numbers	B1	or, e.g. pick numbers from a hat or other sensible
		2	
6(iii)	$\text{Var}(p) = \frac{\frac{47}{350}(1-\frac{47}{350})}{350}$ (= 0.000332152)	M1	
	$z = 1.645$	B1	
	$\frac{47}{350} \pm z\sqrt{\frac{\frac{47}{350}(1-\frac{47}{350})}{350}}$	M1	Must be a z value
	0.104 to 0.164 (3 sf)	A1	Must be an interval
		4	
6(iv)	1.25×1.645 (= 2.056)	M1	or $1.25 \times \text{their width} \div 2 \div \text{their } \sqrt{\frac{\frac{47}{350}(1-\frac{47}{350})}{350}}$ (Complete method)
	$\Phi(2.056)$ (= 0.980)	M1	Attempt $\Phi(\text{their } z)$
	$x = 96$ (2 sf)	A1	Allow 0.96 (2 sf) CWO
		3	

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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	Guidance
1(i)	0.0842 (3 sf)	B1	
		1	
1(ii)	$e^{-5} \times \frac{5^n}{n!} = e^{-5} \times \frac{5^{n+1}}{(n+1)!}$	B1	or $\frac{5^n}{n!} = \frac{5^{n+1}}{(n+1)!}$ or better ISW
		1	
1(iii)	$1 = \frac{5}{n+1}$ $n = 4$	B1	
		1	

Question	Answer	Marks	Guidance
2(i)	Normal with mean 372	B1	
	$sd = \frac{54}{\sqrt{36}}$	M1	or variance = $\frac{54^2}{36}$ M1
	(= 9)	A1	(= 81) A1
		3	
2(ii)	Pop normal	B1	Allow X is normal
		1	

Question	Answer	Marks	Guidance
3(i)	$\text{Est}(\mu) = 1.85$	B1	
	$\text{Est}(\sigma^2) = \frac{50}{49} \left(\frac{175.25}{50} - '1.85'^2 \right)$	M1	Allow $\sqrt{\frac{50}{49} \left(\frac{175.25}{150} - '1.85'^2 \right)}$ or 0.0290 for M1
	$= 0.0842 \text{ (3 sf) or } \frac{33}{392}$	A1	Cao If $\frac{50}{49}$ omitted (giving var = 0.0825 or sd = 0.287) M0A0
		3	
3(ii)	H_0 : Pop mean time = 1.9 (h) H_1 : Pop mean time < 1.9 (h)	B1	Allow ' μ ' but not just 'mean'
	$\pm \frac{1.85 - 1.9}{\sqrt{\frac{0.0842}{50}}}$	M1	$\pm \frac{1.85 - 1.9}{\frac{0.290}{\sqrt{50}}}$ Accept totals method $(92.5 - 95) / \sqrt{4.21}$
	$= -1.22$	A1	$= -1.22$
	comp $z = -1.645$	M1	Or other valid comparison 0.888 or $0.889 < 0.95$ OR 0.111 or $0.112 > 0.05$
	No evidence that mean time < 1.9 h	A1	FT their z. Correct conclusion. No contradictions If $\frac{50}{49}$ not used in (1): var = 0.8225, sd = 0.907, cr = 1.17 can score all marks in (ii) Note- 2 tail test can score B0 M1 A1 M1 (comparison with 1.96) A0 (no ft) max3/5
		5	

Question	Answer	Marks	Guidance
4	Use of $1.5X_1 - X_2$ or similar	B1	
	$E(1.5X_1 - X_2) = 1.5(110) - 110 (= 55)$	B1	or $E(X_1 - 1.5X_2) = 110 - 1.5(110) (= -55)$
	$\text{Var}(1.5X_1 - X_2) = 1.5^2 \times 1050 + 1050$ (or 3412.5)	M1	Correct expression or result
	$\frac{0-55}{\sqrt{3412.5}}$ or $\frac{0-(-55)}{\sqrt{3412.5}}$ ($= \pm 0.942$)	M1	Their '55'. Allow incorrect var (dep > 0 and $\neq 1050$)
	$1 - \Phi(0.942)$	M1	Area consistent with their working
	$= 0.173$	A1	
	Ans 0.346 (3 sf)	B1	FT double their prob (must be <1)
		7	

Question	Answer	Marks	Guidance
5(i)	$H_0: p = 0.1$ $H_1: p < 0.1$	B1	
		1	
5(ii)	B(40, 0.1) stated or implied by use of	B1	e.g. by ${}^{40}C_x$ or $0.9^p \times 0.1^q$ ($p + q = 40$)
	$0.9^{40} + 40 \times 0.9^{39} \times 0.1$	M1	Correct working (if seen). If working not seen, M1 may be implied by 0.0805
	$= 0.0805$	A1	
		3	

Question	Answer	Marks	Guidance
5(iii)	$z = 1.645$	B1	seen
	$\frac{6}{80} \pm z \sqrt{\frac{\frac{6 \times (80-6)}{80}}{80}}$	M1	Formula of correct form. Must be a 'z'
	$= 0.0266 \text{ to } 0.123 \text{ (3 sfs)}$	A1	Allow 0.03 to 0.12 or better Must be an interval
		3	
5(iv)	10% (or manufacturer's claim) is within CI Hence no reason to question claim	B1	FT Allow '10% is within CI, accept claim' oe Must include both parts. No contradictions. FT their CI Note if CI is centred on 0.1 allow ft 0.075 is within CI, accept claim
		1	

Question	Answer	Marks	Guidance
6(i)	$a \int_1^b \frac{1}{x^2} dx = 1$	M1	Attempt int $f(x)$ and $= 1$, ignore limits
	$a \left[-\frac{1}{x} \right]_1^b = 1$	A1	correct integ and limits $= 1$
	$a \left[1 - \frac{1}{b} \right] = 1$ or $a \times \frac{b-1}{b} = 1$ $b = \frac{a}{a-1}$ AG	A1	No errors seen
		3	

Question	Answer	Marks	Guidance
6(ii)	$a \int_1^{\frac{3}{2}} \frac{1}{x^2} dx = \frac{1}{2}$ $a \left[-\frac{1}{x} \right]_1^{\frac{3}{2}} = \frac{1}{2}$	M1	Attempt int f(x) with limits 1 to $\frac{3}{2}$ and $= \frac{1}{2}$
	$a \left[1 - \frac{2}{3} \right] = \frac{1}{2}$	A1	oe correct equn in <i>a</i>
	$a = \frac{3}{2}, b = 3$	A1	Both
		3	
6(iii)	$\frac{3}{2} \int_1^3 \frac{1}{x} dx$	M1	Attempt int $xf(x)$, ignore limits – condone missing <i>a</i>
	$= \frac{3}{2} [\ln x]_1^3$	A1	FT Correct integ and <i>their</i> limits 1 to <i>b</i> – condone missing <i>a</i>
	$= \frac{3}{2} \ln 3$ or 1.65 (3 sf)	A1	FT <i>their a</i> and <i>b</i> (valid <i>b</i> i.e. >1)
		3	

Question	Answer	Marks	Guidance
7(i)	Max no. of passengers plane can take oe	B1	oe e.g. No of passengers who bought tickets
		1	

Question	Answer	Marks	Guidance
7(ii)	$\lambda = 3.2$	B1	
	$e^{-3.2}(\frac{3.2^3}{3!} + \frac{3.2^4}{4!} + \frac{3.2^5}{5!})$	M1	Any λ . Allow one end error
	$= 0.5146 = 0.515$ (3 sfs)	A1	SR Use of Bin(640,0.005) scores B1 (only) for 0.516
		3	
7(iii)	$n > 50$	B1	Accept n is large
	$np = 1.6$, which is < 5 or $p=0.005$ which is < 0.1	B1	Allow $np = 3.2$
		2	
7(iv)	H_0 : Pop mean (for 5 days) = 8 H_1 : Pop mean (for 5 days) < 8	B1	or Pop mean (for 1 day) = 1.6 Pop mean (for 1 day) < 1.6 Allow λ or μ but not just ‘mean’
	$e^{-8}(1 + 8 + \frac{8^2}{2!})$	M1	Any λ ($\neq 1.6$) No end errors. Accept use of Bin(1600,0.005) $P(0,1,2)=0.0136$
	$= 0.0138$	A1	
	Comp 0.025	M1	Valid comparison
	Evidence that mean no. failing to arrive has decreased	A1	FT their ‘0.0138’ or ‘0.0136’. No contradictions
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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.

Question	Answer	Marks	Guidance
1	$0.6 \pm z \sqrt{\frac{0.4 \times 0.6}{100}}$	M1	Recognisable value of z
	$z = 2.326$	B1	2.326 to 2.329
	0.486 to 0.714 (3 sf)	A1	Must be an interval
		3	

Question	Answer	Marks	Guidance
2	$\frac{50}{49} \left(\frac{4361}{50} - \bar{x}^2 \right) = 9.62$	M1	or $\left(\frac{4361}{49} - \frac{(\Sigma x)^2}{50 \times 49} \right) = 9.62$ BOD regarding symbols used
	$\bar{x}^2 = \frac{4361}{50} - 9.62 \times \frac{49}{50} = 77.7924$	A1	$(\Sigma x)^2 = 4361 \times 50 - 9.62 \times 50 \times 49 = 194481$ or $\Sigma x = 441$ (Σx) or ($\bar{x}$) must be correctly identified
	$\bar{x} = 8.82$ (3 sf)	A1	SC use of ‘biased’ leading to 8.81 B1
		3	

Question	Answer	Marks	Guidance
3(i)	D more likely to be chosen	B1	oe, e.g. $P(D) > P(A)$ e.g. $P(A)=P(B)=P(C)=1/6$ $P(D)=1/2$ no contradictions
		1	
3(ii)	Reject scores of 5 or 6	B1	or other correct: choose D when the score is 4
		1	

Question	Answer	Marks	Guidance
3(iii)	AB AC AD BC BD CD	B1	
	Allocate as follows: 1: AB; 2: AC; 3: AD; 4: BC; 5: BD 6: CD	B1	or similar
		2	

Question	Answer	Marks	Guidance
4	Total ~ N(1208, ...)	B1	
	Var(total) (= $10 \times 1.2 + 20 \times 0.7 (+ 0)$) = 26	B1	May be implied by next line
	$\pm \frac{1200 - 1208}{\sqrt{26}}$ (= -1.569)	M1	FT their mean and var of total mass, e.g. allow 1200 and 11.24 (from $10 \times 1.2^2 + 20 \times 0.7^2$)
	$1 - \Phi(-1.569)$	M1	Correct area consistent with their working
	= 0.0583 (3 sf)	A1	
		5	

Question	Answer	Marks	Guidance
5	H_0 : Pop mean = 20 H_1 : Pop mean $\neq$ 20	B1	Accept μ
	$\frac{\Sigma x}{6} \quad \quad \quad (= \frac{126.9}{6} = 21.15)$	M1	Attempted or 126.9 and 11.64 attempted
	$\frac{'21.15'-20}{\sqrt{\frac{1.94}{6}}}$	M1	Must have $\sqrt{6}$ or $\frac{120-126.9}{\sqrt{11.64}}$ no mixed method
	= 2.022	A1	
	$2(1 - \phi('2.022')) = 2(1 - '0.9784') = 0.0432)$	M1	FT $2 \times (1 - '.9784')$
	$\alpha = 4.32$ (3 sf)	A1	FT Allow 4.3 or 4, if correct working seen, or clearly implied, as far as 0.0216 FT their z, no error seen One-tail test scores maximum 3/6
		6	

Question	Answer	Marks	Guidance
6(i)	$\frac{3}{a^3} \int_0^a x^2 dx$ $(= \frac{3}{a^3} \left[\frac{x^3}{3} \right]_0^a)$	M1	Attempt to integrate f(x) with limits 0 and a (condone missing $\frac{3}{a^3}$)
	$= \frac{3a^3}{3a^3}$	A1	$\frac{3a^3}{3a^3} - 0$ or better seen
	= 1 Hence f is pdf for all a	A1	Answer = 1 and comment
		3	
6(ii)	$\frac{3}{a^3} \int_0^2 x^2 dx = 0.5$ $\frac{3}{a^3} \left[\frac{x^3}{3} \right]_0^2 = 0.5$	M1	Attempt to integrate f(x)=0.5, limits 0 and 2 oe, condone missing $\frac{3}{a^3}$
	$\frac{3}{a^3} \times \frac{8}{3} = 0.5$ oe	A1	$\frac{2^3}{3} - 0$ or better, condone missing $\frac{3}{a^3}$
	$a^3 = 16$ or $a = \sqrt[3]{16}$ (= 2.52 AG)	A1	Convincingly obtained Note: Attempt to verify 2.52, M1 as stated except not equated to 0.5. A1 as stated, A1 for evaluation to 0.499..apprx 0.5
		3	

Question	Answer	Marks	Guidance
6(iii)	$\frac{3}{16} \int_0^{2.52} x^3 dx$ $= \frac{3}{16} \left[\frac{x^4}{4} \right]_0^{2.52}$	M1	Attempt integ $xf(x)$, correct limits, condone missing $\frac{3}{a^3}$
	$= \frac{3}{16} \times \frac{40.317}{4}$	A1	$\frac{2.52^4}{4} - 0$ or better, condone missing $\frac{3}{a^3}$
	$= 1.89$ (3 sf)	A1	
		3	

Question	Answer	Marks	Guidance
7(i)	Use of Po(2.8)	M1	May be implied
	$1 - e^{-2.8} \left(1 + 2.8 + \frac{2.8^2}{2} \right)$	M1	Any λ allowing one end error
	$= 0.531$ or $0.53(0)$ (3 sf)	A1	SC Binomial 0.534 B1
		3	
7(ii)	Use of Po(5.8)	M1	May be implied
	$e^{-5.8} \times \frac{5.8^6}{6!}$	M1	Any λ
	$= 0.16(0)$ (3 sf)	A1	
		3	

Question	Answer	Marks	Guidance
7(iii)	Use of N(58, 58)	M1	May be implied or N(58, 55.38)
	$\frac{50.5 - '58'}{\sqrt{'58'}} (= -0.985)$	M1	Standardised with their values, allow wrong or incorrect cc
	$\Phi('0.985')$	M1	Correct area consistent with their working or $\Phi("1.008)$
	= 0.838 (3 sf)	A1	or 0.843
		4	

Question	Answer	Marks	Guidance
8(i)	$H_0: p = \frac{1}{4}$ $H_1: p > \frac{1}{4}$	B1	
	${}^{10}C_6(\frac{1}{4})^6(\frac{3}{4})^4 + {}^{10}C_7(\frac{1}{4})^7(\frac{3}{4})^3 + {}^{10}C_8(\frac{1}{4})^8(\frac{3}{4})^2 +$ $10(\frac{1}{4})^9(\frac{3}{4}) + (\frac{1}{4})^{10}$	M1	Correct terms, allow one term incorrect or omitted or extra or summing all correct terms from 0 to 5 allow one term incorrect or omitted or extra
	= 0.0197	A1	or 0.9803
	comp '0.0197' with 0.01	M1	Valid comparison with 0.01 or valid comparison with 0.99
	No evidence to conclude $p > \frac{1}{4}$	A1	FT No contradictions Use of two-tail test can score BOM1A1M1(comparison with 0.005) A0
		5	
8(ii)	${}^{10}C_7(\frac{1}{4})^7(\frac{3}{4})^3 + {}^{10}C_8(\frac{1}{4})^8(\frac{3}{4})^2 + 10(\frac{1}{4})^9(\frac{3}{4}) + (\frac{1}{4})^{10}$	M1	Their $P(X \geq 6) - {}^{10}C_6(0.25)^6(0.75)^4$
	P(Type I) = 0.00351 (3 sf)	A1	Accept 0.00348 to 0.00351
		2	
8(iii)	C.R is $X \geq 7$ $P(\text{Type II}) = 1 - P(X \geq 7 p = \frac{3}{5}) =$	M1	May be implied
	$1 - ({}^{10}C_7(\frac{3}{5})^7(\frac{2}{5})^3 + {}^{10}C_8(\frac{3}{5})^8(\frac{2}{5})^2 + 10(\frac{3}{5})^9(\frac{2}{5}) + (\frac{3}{5})^{10})$	M1	Accept $1 - P(X \geq 8 p = \frac{3}{5})$ or $1 - P(X \geq 6 p = \frac{3}{5})$
	= 0.618	A1	
		3	