



General Certificate of Education

Mathematics 6360

MS03 Statistics 3

Mark Scheme

2007 examination - June series

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Key to mark scheme and abbreviations used in marking

M	mark is for method		
m or dM	mark is dependent on one or more M marks and is for method		
A	mark is dependent on M or m marks and is for accuracy		
B	mark is independent of M or m marks and is for method and accuracy		
E	mark is for explanation		
✓ or ft or F	follow through from previous incorrect result	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
-x EE	deduct x marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

MS03

Q	Solution	Marks	Total	Comments
1(a)	Samples are independent or random	B1	6	AWFW 2.32 to 2.33 Form Allow: sigmas, A&B or 1&2 and $n - 1$ Correct \checkmark on z only $s_p = 7830$ to 7850 $1372 \pm (1830$ to $1845)$
	$98\% \Rightarrow z = 2.3263$	B1		
	CI for $\mu_1 - \mu_2$ is:	M1		
	$(\bar{x}_S - \bar{x}_A) \pm z \times \sqrt{\frac{s_S^2}{n_S} + \frac{s_A^2}{n_A}}$	A1		
	$(19268 - 17896) \pm 2.3263 \times \sqrt{\frac{7321^2}{175} + \frac{8205^2}{225}}$	A1 \checkmark		
(b)	ie $1372 \pm (1805$ to $1820)$ or $(-450$ to $-430, 3170$ to $3200)$	A1	2	AWFW \checkmark on CI; OE
	Confidence interval includes zero so (at 5% level) Mean starting salaries may be equal	B1 \checkmark \uparrow dep \uparrow B1 \checkmark		
Total			8	

MS03 (cont)

Q	Solution	Marks	Total	Comments
2(a)	$P(\geq 18 \text{Road}) = 0.85$	B1	1	CAO; OE; not 85
(b)	$P(18 \text{ to } 64) =$ $P(\text{Route}) \times P(18 \text{ to } 64 \text{Route}) =$ $(0.25 \times 0.80) + (0.60 \times 0.35) + (0.55 \times 0.40)$ $= 0.20 + 0.21 + 0.22 = 0.63$	M1 A1 A1	3	Use of 3 possibilities, each the product of 2 probabilities At least 1 term correct CAO; OE
(c)	$P(\text{FR} \cap >64) = P(\text{FR}) \times P(>64 \text{FR})$ $= 0.35 \times 0.15$ $= 0.052 \text{ to } 0.053$	B1 B1	2	Correct expression AWFW (0.0525)
(d)	$P(\text{FR} >64) = \frac{(c)}{P(>64)} =$ $\frac{0.0525}{(0.25 \times 0.05) + (0.35 \times 0.15) + (0.40 \times 0.35)}$ $= \frac{0.0525}{0.0125 + 0.0525 + 0.1400} = \frac{0.0525}{0.205}$ $= 0.256 \text{ or } \frac{21}{82}$	M1 M1 A1 A1 A1	5	$\frac{\text{answer}(c)}{\sum(3 \times 2) \text{ probabilities}}$ At least 2 terms correct CAO AWRT/CAO; OE
Total			11	

MS03 (cont)

Q	Solution	Marks	Total	Comments
3(a)	$H_0: p_K = p_S$ $H_1: p_K \neq p_S$	B1		Both; OE; allow A&B or 1&2
	SL $\alpha = 0.05$ CV $ z = 1.96$	B1		CAO
	$\hat{p} = \frac{(150 \times 0.28) + (250 \times 0.34)}{400}$	M1		Used
	$= \frac{127}{400}$ or 0.317 to 0.318	A1		CAO/AFWW (0.3175)
	$z = \frac{(\hat{p}_K - \hat{p}_S) - 0}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_K} + \frac{1}{n_S}\right)}}$	M1		Used; accept unpooled denominator
	$ z = \frac{ 0.28 - 0.34 }{\sqrt{0.3175 \times 0.6825 \left(\frac{1}{150} + \frac{1}{250}\right)}}$	A1✓		✓ on \hat{p} ; accept no pooling
	$= 1.24 $ to $ 1.25 $	A1		AWFW; $ 1.26 $ to $ 1.27 $
	Thus accept H_0 as $ z < 1.96$	A1✓		✓ on z and CV with same sign
	Thus no evidence, at 5% level, of a difference between two proportions of male customers in two salons	E1✓	9	✓ on z and CV with same sign In context and qualified
	(b)	Zero	B1	
since Cannot make a Type I error when H_0 is false		B1	2	OE
	Total		11	

MS03 (cont)

Q	Solution	Marks	Total	Comments
4	98% $\Rightarrow z = 2.5758$	B1		AWFW 2.57 to 2.58
	CI width is $2 \times \frac{z\sigma}{\sqrt{n}}$	M1		Used; allow $\frac{z\sigma}{\sqrt{n}}$
	Thus $2 \times \frac{2.5758 \times 0.08}{\sqrt{n}} = 0.05$	A1✓		OE; ✓ on z; allow no '2 ×'
	Thus $\sqrt{n} = 8.24256$	m1		Solving for \sqrt{n} or n
	Thus $n = 67.9 \Rightarrow 68$	A1✓		AWRT; ✓ on z
	Thus, to nearest 5, $n = 70$	A1	6	CAO
	Total		6	
5	$D = \sum^3 X_i - \sum^2 Y_i$ or $D' = \sum^2 Y_i - \sum^3 X_i$	M1		Used or implied
	have means $\mu = 162 - 166 = -4$ $\mu = 166 - 162 = +4$	B1		CAO either
	and variance $\sigma^2 = (3 \times 2^2) + (2 \times 3^2) = 12 + 18$ $= 30$	M1 A1		Use of $[a \times \text{Var}(Z)]$; implied CAO
	$P\left(\sum^3 X_i < \sum^2 Y_i\right) =$ $P(D < 0)$ or $P(D' > 0) =$	M1		Used or implied
	$P\left(Z > \frac{0 - (-4)}{\sqrt{30}}\right)$ or $P\left(Z > \frac{0 - (+4)}{\sqrt{30}}\right) =$	m1		Standardising 0 using μ and $\sqrt{\sigma^2}$
	$P(Z < +0.73)$ or $P(Z > -0.73) =$ 0.767 to 0.768	A1	7	AWFW
	Total		7	

MS03 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$E(X) = \sum_{x=0}^n x \times \binom{n}{x} p^x (1-p)^{n-x}$	M1		Use of $\sum x \times P(X=x)$
	$= \sum_{x=1}^n \frac{n!}{(x-1)!(n-x)!} p^x (1-p)^{n-x}$	M1		Expansion of ${}^n C_x$; cancelling of x (Ignore limits)
	$= np \times \sum_{x=1}^n \frac{(n-1)!}{(x-1)!(n-x)!} p^{x-1} (1-p)^{n-x}$	M1		Factors of n and p (Ignore limits)
	$= np \times \sum P(X=x) B(n-1, p) = np$	M1	4	AG; must be convincing
(ii)	$\text{Var}(X) = E(X^2) - (E(X))^2$	M1		Used
	$= [E(X^2) - E(X)] + E(X) - (E(X))^2$			
	$= n(n-1)p^2 + np - n^2p^2$	m1		Attempted
	$= np(1-p)$	A1	3	AG; must be convincing
(iii)	Thus $np(1-p) = 3(1-p) = 2.97$	M1		Substituting μ in σ^2
	Thus $1-p = \frac{2.97}{3} = 0.99$			
	Thus $p = 0.01$ and $n = 300$	A1 A1	3	CAO CAO
(iv)	$B(300, 0.01) \sim \text{Po}(3)$	B1		CAO; PI
	$P(X > 2) = 1 - P(X \leq 2)$	M1		Must be applied to Poisson
	$= 1 - 0.4232 = 0.577$	A1	3	AWRT

MS03 (cont)

Q	Solution	Marks	Total	Comments
6(a)			13	
(b)	$Y \sim B(500, 0.45)$ or $Y \sim (\text{normal})$ with mean $\mu = 225$ and variance $\sigma^2 = 123.75$ or standard deviation $\sigma = 11.124$ (At least) half $\Rightarrow (\geq) 250$ $P(Y_B \geq 250) = P(Y_N > 249.5) =$ $P\left(Z > \frac{249.5 - 225}{\sqrt{123.75}}\right) =$ $P(Z > 2.20) = 1 - P(Z < 2.20)$ $= 0.0138$ to 0.014 Note: Use of $\frac{0.5 - 0.45}{\sqrt{0.000495}} \Rightarrow$ max of 5 marks Use of $\frac{0.499 - 0.45}{\sqrt{0.000495}} \Rightarrow$ max of 7 marks	 B1 B1 B1 B1 M1 m1 A1	 7	 PI AWFW 123 to 124 AWFW 11.05 to 11.15 CAO CAO Standardising 249.5, 250 or 250.5 with c's μ and $\sqrt{\sigma^2}$ Area change Use of distribution of \hat{p} Use of distribution of \hat{p} with continuity correction
	Total		20	

MS03 (cont)

Q	Solution	Marks	Total	Comments
7(a)	$H_0: \lambda = 13$	B1		CAO; OE
	$H_1: \lambda < 13$	B1		CAO; OE
	$P(R \leq 10 \text{Po}(13))$	M1		Used or implied
	$= 0.2517$	A1		AWFW 0.251 to 0.252
	Prob of $0.2517 > 0.10$ (10%) $z = -0.83$ to $-0.70 > -1.28$	M1		Comparison of prob with 0.10 Comparison of z with -1.28
	Thus no evidence, at 10% level, of a reduction in the mean value of R	A1✓	6	✓ on probability or z In 'context' and qualified
(b)	Require $P(R \leq r \text{Po}(13)) \approx 0.10$	M1		Stated or implied
	Critical Region is $R \leq 8$ or $R < 9$	A1	2	Accept $R = 8$ May be scored in (a)
(c)	Require $P(\text{accept } H_0 H_0 \text{ false})$	B1		OE; PI
	$= P(R > 8 \text{Po}(6.5))$	M1		Use of $\text{Po}(6.5)$
	$= 1 - P(R \leq 8 \text{Po}(6.5))$	m1		
	$= 1 - 0.7916$			
	$= 0.208$ to 0.209	A1	4	AWFW (0.2084)
	Total		12	
	TOTAL		75	