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ASSESSMENT and
QUALIFICATIONS
ALLIANCE

General Certificate of Education

Mathematics 6360

MS2B Statistics 2B

Mark Scheme

2005 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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	OE	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)

Application of Mark Scheme

No method shown:	
Correct answer without working	mark as in scheme
Incorrect answer without working	zero marks unless specified otherwise
More than one method / choice of solution:	
2 or more complete attempts, neither/none crossed out	mark both/all fully and award the mean mark rounded down
1 complete and 1 partial attempt, neither crossed out	award credit for the complete solution only
Crossed out work	do not mark unless it has not been replaced
Alternative solution using a correct or partially correct method	award method and accuracy marks as appropriate

MS2B

<table>
<tr><th>Q</th><th>Solution</th><th>Marks</th><th>Total</th><th>Comments</th></tr>
<tr><td>1(a)</td><td>$\mathrm{P}(X=2)=\dfrac{e^{-2.6}(2.6)^2}{2!}$
$=0.251$</td><td>M1
A1</td><td>2</td><td>0.5184 – 0.2674 =0.251</td></tr>
<tr><td>(b)(i)</td><td>$Y \sim \mathrm{P}_o(13)$</td><td>B1</td><td>1</td><td>Poisson **and** 13</td></tr>
<tr><td>(ii)</td><td>$\mathrm{P}(Y \geq 15)=1-\mathrm{P}(Y<14)$
$=1-0.6751$
$=0.3249$
$=0.325$
$\therefore\ p=(0.3249)^4$
$p=0.0111$ to 0.0112</td><td>M1
A1√
M1 A1√</td><td>4</td><td>On their λ from b (i)
On their $p(Y \geq 15)$</td></tr>
<tr><td></td><td>**Total**</td><td></td><td>**7**</td><td></td></tr>
<tr><td>2</td><td>H_0 : time of day has no effect on the outcome of a frame of snooker
<table>
<tr><th>O_i</th><th>E_i</th><th>$|O_i - E_i| - 0.5$</th><th>χ^2</th></tr>
<tr><td>**30**</td><td>**25.92**</td><td>**3.58**</td><td>**0.4945**</td></tr>
<tr><td>**18**</td><td>**22.08**</td><td>**3.58**</td><td>**0.5805**</td></tr>
<tr><td>**24**</td><td>**28.08**</td><td>**3.58**</td><td>**0.4564**</td></tr>
<tr><td>**28**</td><td>**23.92**</td><td>**3.58**</td><td>**0.5358**</td></tr>
<tr><td>**100**</td><td>**100**</td><td></td><td>**2.0672**</td></tr>
</table>
$\chi^2_{5\%}(1)=3.841$
$2.07 < 3.841$ $\therefore$ do not reject H_0
No evidence to suggest that the time of day has an effect on the outcome of a frame of snooker played by Syd.</td><td>B1
M1A1
M1
M1
A1
B1B1√
A1√
E1√</td><td>10</td><td>H_0 : outcome does not depend on time of day
For E's
For use of Yates' correction attempted calculation of χ^2 (even if Yates' correction not used)
For $\nu=1$ and χ^2
On their χ^2</td></tr>
<tr><td></td><td>**Total**</td><td></td><td>**10**</td><td></td></tr>
<tr><td>3(a)</td><td>$\sum x=15.8$
$\sum x^2=25.0592$
$\bar{x}=\dfrac{15.8}{10}=1.58$
$s^2=\dfrac{25.0592}{9}-\dfrac{10}{9}(1.58)^2$
$=0.0105\dot{7}$</td><td>B1
B2</td><td>3</td><td>$\bar{X} \sim \mathrm{N}\left(\mu, \dfrac{\sigma^2}{10}\right)$
(AWRT 0.011)
$(s=0.1028)$</td></tr>
<tr><td>(b)</td><td>90% CI for μ
$1.58 \pm \dfrac{s}{\sqrt{10}} \times 1.833$
$(1.52, 1.64)$</td><td>M1A1
ft
B1
B1√
A1√</td><td>5</td><td>1.58 ± 0.0596
for $\nu=9$
for t
for interval</td></tr>
<tr><td></td><td>**Total**</td><td></td><td>**8**</td><td></td></tr>
</table>

MS2B (cont)

Q	Solution	Marks	Total	Comments
4(a)	$k = 0.1$	B1	1	OE.
(b)	E(X) = 1	B1	1	
(c)	$\mathrm{P}(X > 0) = 6 \times 0.1$ $= 0.6$	M1 A1	2	
(d)	$\mathrm{P}(\lvert X \rvert > 3.5) = 1 - \mathrm{P}(\lvert X \rvert < 3.5)$ $= 1 - 0.7$ $= 0.3$	M1 A1 A1	3	
	Alternative solution $\mathrm{P}(X < -3.5) + \mathrm{P}(X > 3.5)$ $= \frac{0.5}{10} + \frac{2.5}{10}$ $= \frac{3}{10}$	(M1) (A1) (A1)		
	Total		**7**	

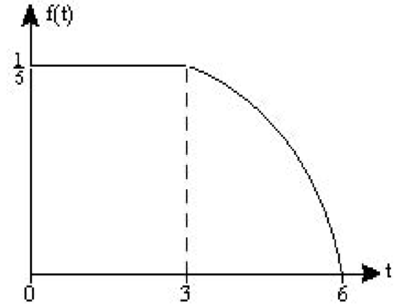
MS2B (cont)

<table>
<tr><th>Q</th><th>Solution</th><th>Marks</th><th>Total</th><th>Comments</th></tr>
<tr><td>5(a)</td><td>$\mathrm{E}(R)=\left(1\times\frac{1}{4}\right)+\left(2\times\frac{1}{2}\right)+\left(4\times\frac{1}{4}\right)$
$=2.25$</td><td>M1A1</td><td></td><td>$2\frac{1}{4}$</td></tr>
<tr><td></td><td>$\mathrm{E}\left(R^2\right)=\left(1\times\frac{1}{4}\right)+\left(4\times\frac{1}{2}\right)+\left(16\times\frac{1}{4}\right)$
$=6.25$</td><td></td><td></td><td>$6\frac{1}{4}$</td></tr>
<tr><td></td><td>$\therefore\ \mathrm{Var}(R)=6.25-(2.25)^2$
$=1.1875$</td><td>M1
A1√</td><td>4</td><td>$1\frac{3}{16}$ (on their E (R))</td></tr>
<tr><td>(b)(i)</td><td><table><tr><td>x</td><td>1</td><td>$\frac{1}{4}$</td><td>$\frac{1}{16}$</td></tr><tr><td>P(X = x)</td><td>$\frac{1}{4}$</td><td>$\frac{1}{2}$</td><td>$\frac{1}{4}$</td></tr></table></td><td>B1</td><td></td><td></td></tr>
<tr><td></td><td>$\mathrm{E}(X)=\left(1\times\frac{1}{4}\right)+\left(\frac{1}{4}\times\frac{1}{2}\right)+\left(\frac{1}{16}\times\frac{1}{4}\right)$</td><td>M1</td><td></td><td></td></tr>
<tr><td></td><td>$=\frac{1}{4}+\frac{1}{8}+\frac{1}{64}$
$=\frac{16+8+1}{64}$
$=\frac{25}{64}$</td><td>A1</td><td>3</td><td>AG</td></tr>
<tr><td>(ii)</td><td>$\mathrm{A}=\left(R+\frac{8}{R}\right)\times\frac{8}{R}=8+\frac{64}{R^2}$</td><td>M1</td><td></td><td>(Attempt at area)</td></tr>
<tr><td></td><td>$\mathrm{E}(\mathrm{A})=\mathrm{E}\left(8+\frac{64}{R^2}\right)=8+\mathrm{E}\left(\frac{64}{R^2}\right)$
$=8+64\times\mathrm{E}(X)$</td><td>M1</td><td></td><td></td></tr>
<tr><td></td><td>$=8+64\times\frac{25}{64}$
$=33$</td><td>A1</td><td>3</td><td>CAO</td></tr>
<tr><td></td><td>Total</td><td></td><td>10</td><td></td></tr>
</table>

MS2B (cont)

Q	Solution	Marks	Total	Comments
6	$\text{H}_0 : \mu = 568$ $\text{H}_1 : \mu < 568$	B1		X ~ contents of cartons of milk $X \sim \text{N}\left(568, \sigma^2\right)$
	1% one-tailed test $\nu = 7$	B1		Under H_0 : $\overline{X} \sim \text{N}\left(568,\ \dfrac{\sigma^2}{n}\right)$
	$\bar{x} = \dfrac{4510}{8} = 563.75$	B1		
	$\Rightarrow \quad \text{s}^2 = \dfrac{254256.8}{7} - \dfrac{8}{7}\left(563.75\right)^2$			
	$s^2 = 7.929$	B2		$\left(s = 2.816\right)$
	$t = \dfrac{563.75 - 568}{2.816/\sqrt{8}}$	M1		
	$t = -4.27$	A1ft		(AWFW =4.27to –4.26)
	$t_{crit} = -2.998$	B1ft		
	reject H_0	A1√		On their t
	Evidence at the 1% level of significance to suggest that the average contents of the cartons have been reduced.	E1√	10	
	Total		**10**	

MS2B (cont)

Q	**Solution**	**Marks**	**Total**	**Comments**
7(a)		B3	3	B1 2 axes with scales B1 horizontal line at 0.2 from 0 to 3 B1 curve from 3 to 6
(b)	$\mathrm{P}(T=3)=0$	B1	1	
(c)	$\mathrm{P}(T \geq 3)=1-\mathrm{P}(T<3)$ $=1-\frac{3}{5}$ $=\frac{2}{5}$	M1 A1	2	$\int_3^6 \frac{1}{45}t(6-t)\mathrm{d}t=\frac{2}{5}$
(d)	$\int_0^m \frac{1}{5}dt = 0.5$ $\left(\frac{t}{5}\right)_0^m = 0.5$ $\frac{m}{5}-0=0.5$ $m=0.5\times 5$ $m=2.5$	M1 A1	2	$\mathrm{P}(T \leq 3)=0.6$ $\therefore\ 0 \leq$ median <3 $\frac{1}{5}m=0.5$ $m=5\times 0.5$ $m=2.5$ AG
(e)	$\mathrm{E}(T)=\int_0^3 \frac{1}{5}t\ dt+\int_3^6 \frac{1}{45}t^2(6-t)\ dt$ $=\left[\frac{1}{10}t^2\right]_0^3+\left[\frac{2}{45}t^3-\frac{1}{180}t^4\right]_3^6$ $=\frac{9}{10}+1.65$ $=2.55$ $\therefore\ \mathrm{P}(\text{median}<T<\text{mean})$ $=\mathrm{P}(2.5<T<2.55)$ $=0.05\times\frac{1}{5}$ $=0.01$	M1 A1A1 A1 M1 A1	6	
	Total		**14**	

MS2B (cont)

Q	Solution	Marks	Total	Comments
8(a)	$H_0 : \mu = 35$ $H_1 : \mu \neq 35$	B1		
	$2 -$ tail test , 1% sig. level			
	under H_0, $\bar{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$			
	$\bar{X} \sim \mathrm{N}\left(35, \frac{144}{100}\right)$	B1		
	$z = \frac{37.9 - 35}{1.2}$	M1		$z = \frac{37.9 - 35}{\text{their } \sigma/\sqrt{n}}$
	$z = 2.42$	A1√		On their $\sigma/\sqrt{n}$
	$z_{crit} = \pm 2.5758$	B1		
	do not reject H_0	A1√		On their z
	Evidence to support the claim that the mean age is 35 years.	E1√	7	
(b)	Accept H_0 when H_0 false Accepting the mean to be 35years when it isn't.	B2	2	Allow B1 if not in context
	Total		**9**	
	Total		**75**	