



General Certificate of Education

Mathematics and Statistics 6320 *Specification B*

MBS8 Statistics 8

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

M	mark is for	method
m	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	accuracy
E	mark is for	explanation
✓ or ft or F		follow through from previous incorrect result
cao		correct answer only
cso		correct solution only
awfw		anything which falls within
awrt		anything which rounds to
acf		any correct form
ag		answer given
sc		special case
oe		or equivalent
sf		significant figure(s)
dp		decimal place(s)
A2,1		2 or 1 (or 0) accuracy marks
-x ee		deduct x marks for each error
pi		possibly implied
sca		substantially correct approach

Abbreviations used in Marking

MC – x	deducted x marks for mis-copy
MR – x	deducted x marks for mis-read
isw	ignored subsequent working
bod	given benefit of doubt
wr	work replaced by candidate
fb	formulae book

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

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Q	Solution	Marks	Total	Comments
1 (a)	Difference (or prices) ~ normal	B1		
	$H_0: \mu_D = 0$ or $\mu_X = \mu_Y$	B1		Both; must relate to population
	$H_1: \mu_D > 0$ or $\mu_X > \mu_Y$			
	SL $\alpha = 0.05$ (5%)			
	DF $\nu = 20 - 1 = 19$	B1		cao
	CV $t = 1.72$ to 1.73	B1		awfw (1.729)
	$s_D^2 = \frac{2577}{20 \text{ or } 19} = 128$ to 136	B1		awfw (128.85 or 135.63)
	or $s_D = 11.3$ to 11.7			(11.35 or 11.65)
	$t = \frac{\bar{d} - \mu_0}{\sqrt{\frac{s_D^2}{n}}} = \frac{5.5}{\sqrt{135.63/20}}$	M1		Use of; accept no μ_0
	$= 2.11$ to 2.13	A1		awfw
	Thus, at 5% level, reject H_0 , so evidence that food items are cheaper in supermarkets than in minimarkets	A1✓	8	ft on t -value and CV
(b)	Randomised block design (RBD)	B1		Accept 'blocking'
	Two-way anova	B1	2	2-factor analysis of variance
	Total		10	

MBS8 (cont)

Q	Solution	Marks	Total	Comments
2				
(a)	To reduce/remove effect of patient to patient variation	B1	1	Or equivalent in context
(b)	Those given new stocking	B1	1	
(c)	<u>Meaning:</u> Patient and doctor/nurse do not know which stocking patient is wearing	B1		Or equivalent in context B0 for single blind trials
	<u>Purpose:</u> To prevent patient and doctor/nurse knowledge influencing perceived effect of stocking prescribed	B1	2	Or equivalent in context B0 for single blind trials
(d)				
(i)	Sign test No numerical values or Yes/No answers Only signs of differences	B1		cao
		B1	2	Either; or clear equivalent
(ii)	Wilcoxon signed rank test or Paired t-test Scores unlikely to be normal Scores can be ranked Scores likely to be symmetrically distributed	B1		cao
	Large sample so mean normal by CLT	B1	2	Or clear matching equivalent
	Total		8	

MBS8 (cont)

Q	Solution	Marks	Total	Comments
3 (a)	<u>Binomial (40, 0.01 or 0.10)</u>	M1		Either used in (a); stated or inferred by a probability
(i)	$P(X \geq 2) = 1 - P(X \leq 1)$ $= 1 - 0.9393 = 0.0607 = \mathbf{0.06}$	A1		awrt
(ii)	$P(X \leq 1) = 0.0805 = \mathbf{0.08}$	A1	3	awrt
(b)	Both probabilities $> \mathbf{0.05}$ (5%) so Plan is not suitable	B1 \checkmark		ft on (a)
(c)	<u>Poisson (0.9 or 9.0)</u> $P(X \geq 4) = 1 - P(X \leq 3)$ $= 1 - 0.9865 = 0.0135 = \mathbf{0.013}$ to $\mathbf{0.014}$ $P(X \leq 3) = 0.0212 = \mathbf{0.021}$	M1 A1 A1		Either used in (c); stated or inferred by a probability awfw awrt
(d)	<u>Poisson (4.5)</u> $\mathbf{0.3423}$ or $(1 - 0.3423) = \mathbf{0.6577}$ $= 0.342(3) \times 0.05$ $= \mathbf{0.017}$	M1 A1 m1 A1		Stated or inferred by a probability; use not required awrt 0.342 or 0.658 Use of awrt
	Total		12	

MBS8 (cont)

Q	Solution	Marks	Total	Comments	
4 (a)	M T W T F Tot 138 126 120 126 132 642	B1		cao; may be implied	
	$SS_T = \sum \sum x_{ij}^2 - \frac{T^2}{n}$	M1		Use of	
	$= 13878 - (642)^2/30 = \mathbf{139.2}$	A1		cao	
	$SS_B = \sum \frac{T_i^2}{n_i} - \frac{T^2}{n}$	M1		Use of	
	$= (82620)/6 - (642)^2/30 = \mathbf{31.2}$	A1		cao	
	$SS_W = SS_T - SS_B = 139.2 - 31.2 = \mathbf{108}$	M1		All SS > 0	
	SV SS DF MS F	B1		cao 4 and 25	
	Days 31.2 4 7.80 1.8				
	Residual 108.0 25 4.32	M1		Use of $F = MS_B/MS_W$	
	Total 139.2 29	A1		awrt 1.8 (1.806)	
	CV $F_{25}^4(0.95) = \mathbf{2.76}$	B1		awrt (2.759)	
	Thus, at 5% level, accept H_0 , so no evidence that daily mean times differ	A1✓	11	ft on F -value and upper tail CV ag	
	(b)	CI for μ is $\bar{x} \pm (t \text{ or } z) \times \frac{s}{\sqrt{n}}$	M1		Use of
		95% & $\nu = 25 \Rightarrow t = \mathbf{2.06}$	B1		awrt (2.060)
		Thus $\frac{642}{30} \pm 2.06 \times \frac{\sqrt{4.32}}{\sqrt{30}}$	A1✓		ft on 642, t or z & 4.32
Thus 21.4 ± 0.8 (20.6, 22.2)		A1	4	awrt	
Note $\frac{642}{30} \pm 2.045 \times \frac{\sqrt{139.2/29}}{\sqrt{30}} \Rightarrow 21.4 \pm 0.8$				M1 B0 A1✓ A1 ft on 642, t & 139.2; Allow 30 rather than 29	
Total		15			

MBS8 (cont)

Q	Solution	Marks	Total	Comments
5	$\mu = 965 \quad \sigma = 8 \quad (n = 5)$			
(a)				
(i)	CL: $\mu \pm z \times \frac{\sigma}{\sqrt{n}}$	M1		Use of; may be implied
	z-values: 1.96(00) and 3.09(02)	B1		Both awrt
	W (95%): $965 \pm 1.96 \times \frac{8}{\sqrt{5}} = 965 \pm 7.01$ (958.0, 972.0)	A1		awrt; allow (958, 972)
	A (99.8%): $965 \pm 3.09 \times \frac{8}{\sqrt{5}} = 965 \pm 11.1$ (953.9 to 954.0, 976.0 to 976.1)	A1	4	awfw; allow (954, 976)
(ii)	CL: $\sigma \times D$	M1		Use of; may be implied M0 for use of $\sigma \times E$
	LAL: $8 \times 0.367 = \mathbf{2.9}$			
	LWL: $8 \times 0.850 = \mathbf{6.8}$	A2, 1	3	awrt;
	UWL: $8 \times 4.197 = \mathbf{33.6}$			$\geq 1 \Rightarrow A1 \quad 4 \Rightarrow A2$
	UAL: $8 \times 5.484 = \mathbf{43.9}$			Accept 3 7 34 44
(b)				
(i)	Means ε LWL to UWL Ranges ε LWL to UWL	B1 \checkmark		Both ; ft on (a)
	Thus under control/no action required	B1	2	dependent on previous
(ii)	Estimate of $\mu = \frac{7712}{8} = \mathbf{964}$	B1	1	cao; $\bar{w} = \frac{160}{8} = 20$
(iii)	$P(W < 950) = P\left(Z < \frac{950 - 964}{8}\right)$	M1		Standardising 950 using ((ii) or 965) & (8 or 8.6 = 20×0.4299)
	$= P(Z < -1.75) = 1 - \Phi(1.75)$	m1		Area change
	$= 1 - 0.95994 = \mathbf{0.04}$	A1	3	awrt (0.04006)
(iv)	4% of tubs are underweight or are less than target/nominal weight Despite machine being under control	A1 \checkmark A1	2	ft on (b)(iii) cao
	Total		15	
	TOTAL		60	