General Certificate of Education

Statistics 6380

SS02   Statistics 2

Mark Scheme

2009 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	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.

SS02

Q	Solution	Marks	Total	Comments
1(a)(i)	0.5488	B1		$0.5485 \sim 0.549$
(ii)	$P(X > 2) = 1 - P(X \le 2)$	M1		
	$= 1 - 0.9769$			
	$= 0.0231$	A1	3	$0.023 \sim 0.0232$
(b)(i)	Po(0.3)	B1		Attempted use of Po(0.3)
(ii)	$P(X \ge 1) = 1 - P(X = 0)$	M1		
	$= 1 - 0.7408$			
	$= 0.259$	A1		$0.259 \sim 0.26$
(ii)	$P(X = 2) = 0.9964 - 0.9631$	M1		Method – includes Po(0.3)
	$= 0.0333$	A1	5	$0.033 \sim 0.0334$
	Total		8	
2(a)	$\mu = 101.6$	B2		CAO (allow 102)
				(or $E(X) = 50 \times 0.40 + 95 \times 0.16 + 135 \times 0.24 + 170 \times 0.20 = 101.6$ M1A1)
	$\sigma = 47.7$	B2	4	$47.69 \sim 47.71$
				(or $E(X^2) = 50^2 \times 0.40 + 95^2 \times 0.16 + 135^2 \times 0.24 + 170^2 \times 0.20 = 12598$ $V(X) = 12598 - 101.6^2 = 2275.44$ s.d. $= \sqrt{2275.44} = 47.7$ M1A1)
(b)(i)	$E(X) = 95 \times 0.45 + 135 \times 0.30 + 170 \times 0.25 = 125.75$	M1		
	$= 126$ to 3sf	A1	2	CAO; AG
(ii)	Will lose 20% of customers $0.8 \times 125.75 = 100.6$	M1		Any relevant calculation attempted
	… which is less than 101.6.	m1		Valid comparison - their figures
	Hence, if estimate is correct, she will take less money.	A1	3	Correct conclusion based on correct working
				or lose $0.2 \times 50 = 10$; gain $0.2 \times (95 - 50) = 9$ or $100 \times 101.6 = 101.60$ $(100 - 120) \times 125.75 = 100.60$
	Total		9	

SS02 (cont)

Q	Solution	Marks	Total	Comments
3(a)	113 million	B1 B1	 2	113 113 million
(b)(i)	Upward trend in London - relatively slow 1994/95 (decrease in 1998/99) - increasing more rapidly 2000/01 onwards.	E1		E1 upward in London
(ii)	Outside London there is a slow downward trend (apart from 1998/99 to 2000/01 when there was little change).	E1 E1	 3	E1 downward outside London E1 additional valid (but not trivial) point
(c)(i)	Increase in fares index outside London far exceeds increase in RPI - this explains reduction in bus journeys outside London. Increase in fares index in London is similar to increase in RPI. Thus any reason for increased bus journeys (eg congestion charge / increased population) should not be inhibited by price.	E1 E1 E1	 3	E1 comparison of fares outside London with RPI E1 comparison of fares in London with RPI E1 comparison of London with outside London E1 any sensible conclusion **Maximum 3**
(ii)	Outside London increase in bus fares > increase in rail fares > both RPI and increase in motoring costs (which have declined in real terms). This may explain reduction in bus journeys. In London increase in bus fares is < increase in rail fares / similar to RPI / only slightly > than increase in motoring costs. This may explain increase in bus journeys.	 E1 E1	 2	 E1 valid comparison outside London E1 valid comparison in London
	Total		**10**	

SS02 (cont)

Q	Solution	Marks	Total	Comments
4(a)	On graph	B1 M1 A1	 3	Scales labelled Method for plot Accurate plot by eye - allow one small slip. Disallow very small scale
(b)	Jun '05 Jan '06 Jun '06 Jan '07 Jun '07 Jan '08 1188 192 1351 238 1499 290 m.a. 690.0 771.5 794.5 868.5 894.5 On graph	 B1 M1 m1 A1	 4	 2-point moving average used Method for moving average Moving average plotted in correct position – must be 2-point Moving average plotted accurately – allow one small slip
(c)	Trend line on graph June effect (500+570+610)/3 = 560	B1 M1 m1 A1	 4	 Method for seasonal effect - ignore sign - may be earned in (d) Method for seasonal effect – allow '06 and '07 only 560 (530 ~ 600) - may be earned in (d)
(d)	Estimate of m.a. June 2009 = 1100 Estimated number of candidates = 1100 + 560 = 1660	B1 M1 A1	 3	1060 ~ 1140 Method for forecast - their figures for positive seasonal effect 1660 (1620 ~ 1720) **SC** allow B1 for in range, no working
(e)	Max for 4 examiners is 4 × 400 = 1600 Estimate of 1660 suggests 5 examiners will be required.	M1 A1	 2	Method - their figures CAO **SC** allow B1 for 5 without explanation
(f)(i)	Limited data available suggests January and June figures are both increasing approximately linearly but at different rates. Using regression on June figures is a sensible method but current trends may not continue.	E1 E1		Limited data; Jan and June increasing at different rates; sensible method; current trends may not continue **any 2 valid points**
(ii)	1800 would still need 5 examiners – no effect	E1√	3	ft no effect - their figures
			19	

SS02 (cont)

Q	Solution	Marks	Total	Comments
5(a)	H_0: $\mu = 19$ H_1: $\mu \neq 19$	B1 B1		B1 one correct hypothesis B1 both hypotheses correct
	$\bar{x} = 19.667$ $z = (19.667 - 19)/(3.5/\sqrt{9}) = 0.571$	M1 m1 A1		Use of $3.5/\sqrt{9}$ Method for z – ignore sign 0.571 (0.57 ~ 0.575)
	c.v. ± 1.96 Accept H_0	B1 A1√		± 1.96 – ignore sign Conclusion – must be compared with correct tail of normal
	Conclude that there is no significant evidence that the mean time for ambulance to arrive is not 19 minutes	A1√	8	In context – needs previous A1√
(b)(i)	H_0: $\mu = 19$ H_1: $\mu < 19$	B1		Both hypotheses – ignore any errors already penalised in (a)
(ii)	-1.6449	B1 B1		1.6449 (1.64 ~ 1.65) Any negative z-value
(iii)	No significant evidence that the mean time for ambulance to arrive is less than 19 minutes.	A1√	4	Needs m mark in (a) and – c.v.
(c)	No significant evidence that target has been achieved.	E1		E1 director's comment incorrect
	Indeed as $\bar{x} = 19.66$ there is no evidence at all.	E1		E1 sample mean greater than 19
	There is however no significant evidence that it has not been achieved.	E1	3	E1 no significant evidence target has not been achieved. E1 no significant evidence target has been achieved **Maximum 3**
	Total		**15**	

SS02 (cont)

Q	Solution	Marks	Total	Comments
6(a)	280 houses	B1		
	Number houses 000 to 279	E1		OE - their total
	Select 3-digit random numbers	E1		
	Ignore repeats	E1		
	and > 279	E1	5	Consistent with their numbering
	Continue until 8 numbers obtained Select corresponding houses			
(b)	Number houses street by street, eg North St 000–062 East St 063–139 South St 140–185 West St 186–279	E1		E1 number houses street by street - may be earned in (a) but more detail required here
	Select a random number between 00 and 34.	E1		E1 idea of systematic sampling E1 choose random starting point
	Choose this house and every 35th house thereafter.	B1	3	B1 every 35th house **Maximum 3**
(c)	Cluster	B1	1	
(d)(i)	If Socrates misses a street there is a substantial probability (0.5) that John will not check any houses in this street.	E1		
(ii)	Systematic preferred	B1		
	John certain to check some houses in each street	E1	3	
(e)	No preference	B1		
	Both equally likely to check houses missed by Mary	E1	2	**SC** allow B1 for systematic because easier to carry out
	Total		**14**	
	TOTAL		**75**	