General Certificate of Education
January 2005
Advanced Subsidiary Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B) Unit Statistics 2

MBS2

Friday 14 January 2005 Morning Session

In addition to this paper you will require:
- an 8-page answer book;
- the AQA booklet of formulae and statistical tables;
- a sheet of graph paper for use in Question 5;
- a ruler.

You may use a graphics calculator.

Time allowed: 1 hour 15 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MBS2.
- Answer **all** questions.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information
- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.

Advice
- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

1 An engineer is employed by a cable installation company to correct problems found by customers. The daily number of call-outs has a Poisson distribution with mean 4. The engineer is paid a fixed amount for up to 5 call-outs in a day, plus a £10 bonus for each call-out in excess of 5.

(a) Find the probability that the engineer receives a bonus payment on any given day. *(2 marks)*

(b) The employer proposes to change to a weekly (five-day) basis for calculating the engineer's pay. As part of the proposal, the £10 bonus will apply to each call-out in excess of 25 during the week.

(i) Use a distributional approximation to calculate the probability that, based upon this proposal, the engineer will receive a bonus payment for any given week. *(5 marks)*

(ii) State, with a reason, whether the engineer would prefer the bonus to be calculated on a daily or a weekly basis. *(2 marks)*

2 An IT company has designed a security product to protect software against hostile interference. In 400 trials, the security product failed 44 times.

(a) (i) Obtain an approximate 90% confidence interval for p, the probability of the security product failing. *(6 marks)*

(ii) Hence comment on a claim, by the IT company, that the security product will repel more than 85% of attempts at hostile interference. *(2 marks)*

(b) State, with a reason, the effect on the width of the confidence interval when:

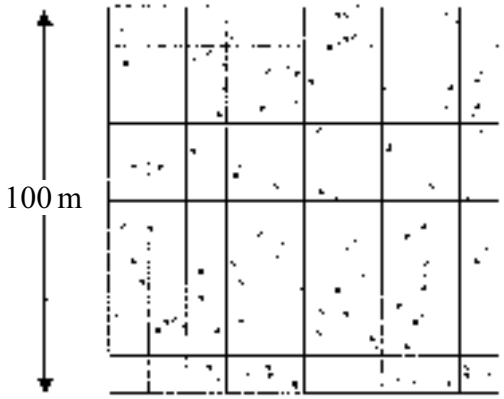
(i) the confidence level is increased;

(ii) the number of trials is increased. *(3 marks)*

3 Janice, a trainee environmental researcher, is asked to measure the plant diversity in an area of 100 m × 100 m at a colliery spoil site. The area has been mapped out into 10 m square blocks. Janice has to identify and record the number of plants within a 1 m quadrat (a 1-metre square frame) at each of 100 selected positions.

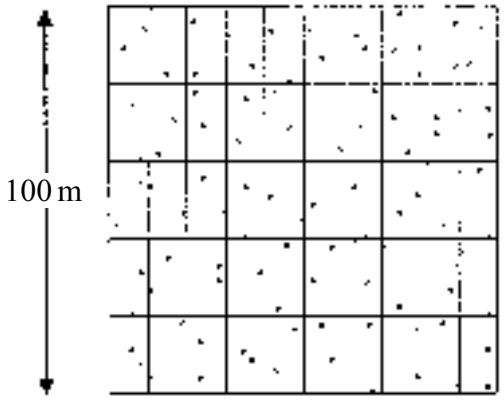
Janice considers three methods for selecting these 100 positions.

Method A



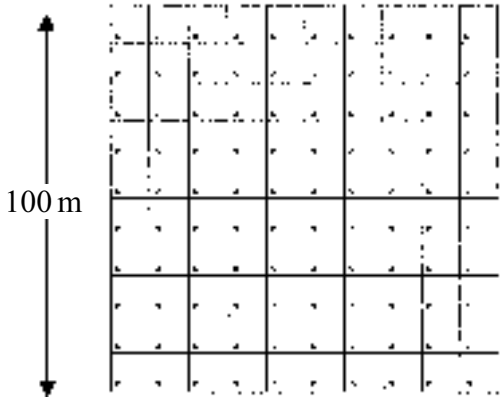
The quadrat is placed at random on 100 positions on the site.

Method B



The quadrat is placed at random in each 10 m square block.

Method C



The quadrat is placed at random in the first 10 m square block, and then placed at the same position within all the other square blocks.

(a) Name the sampling technique used in **each** of the three methods. *(3 marks)*

(b) State, in context, one advantage and one disadvantage for **each** sampling technique. *(6 marks)*

(c) Provide Janice with a set of instructions on how random numbers may be used to obtain the 100 positions using Method B. *(3 marks)*

4 Quarterly data relating to visits abroad by UK residents to non-EU Europe were published in *Transport Travel and Tourism.*

Quarter	x	Number of visits (thousands)	Moving average	Centred moving average, y
1998 Q1	1	595		
Q2	2	1048		
			1078.75	
Q3	3	1792		1085.625
			1092.5	
Q4	4	880		1097.875
			1103.25	
1999 Q1	5	650		1081.75
			1060.25	
Q2	6	1091		1045
			1029.75	
Q3	7	1620		1036.5
			1043.25	
Q4	8	758		1064.625
			p	
2000 Q1	9	704		r
			q	
Q2	10	1262		1136.625
			1155.5	
Q3	11	1747		1162.125
			1168.75	
Q4	12	909		1178
			1187.25	
2001 Q1	13	757		1212
			1236.75	
Q2	14	1336		1244.25
			1251.75	
Q3	15	1945		
Q4	16	969		

(a) (i) Calculate the values of the moving averages p and q. *(3 marks)*

(ii) Hence calculate the value of the centred moving average r. *(2 marks)*

(b) The equation of the regression line for the centred moving averages may be written in the form $y = 15.28x + c$. Find the value of c to one decimal place. *(3 marks)*

(c) Use your equation to calculate an estimate of the second quarter seasonal effect. *(4 marks)*

(d) Estimate the number of visits abroad by UK residents to non-EU Europe in the second quarter of 2002. *(4 marks)*

(e) The actual number of visits in the second quarter of 2002 was 1 323 000. Comment on the apparent suitability of your method of forecasting. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

5 [A sheet of graph paper is provided for use in this question.]

The following data refer to gross weekly earnings in occupations within the occupation classification "Associate Professional and Technical Occupations".

		Gross weekly earnings				
		Lowest decile	Lower quartile	Median	Upper quartile	Highest decile
		£ per week				
Associate Professional and Technical Occupations	males	303.5	383.9	479.9	590.8	772.5
	females	264.7	339.2	418.7	514.9	614.2
Science and Technology Associate Professionals	males	278.3	345.5	432.9	542.0	696.9
	females	218.7	276.7	360.9	462.4	594.1
Health and Social Welfare Associate Professionals	males	278.6	345.9	418.6	491.8	570.8
	females	296.4	358.3	424.4	503.3	565.8
Protective Service Occupations	males	380.9	441.6	497.3	547.3	620.4
	females	339.9	380.8	455.3	537.9	591.6
Culture, Media and Sports Occupations	males	281.1	355.1	479.9	681.0	977.1
	females	249.5	326.4	409.8	593.6	799.8
Business and Public Service Associate Professionals	males	311.9	399.0	518.2	671.8	940.5
	females	257.9	313.5	421.7	547.5	693.1

Source: extract from *New Earnings Survey* (Office for National Statistics) 2002

(a) State the average weekly gross earnings for a male employed in an Associate Professional and Technical Occupation. *(1 mark)*

(b) Explain, in context, the meaning of upper quartile. *(1 mark)*

(c) Identify the occupation in which the difference between the gross weekly earnings of males and females is the least. *(1 mark)*

(d) Draw box and whisker plots, on the same axis, for males and females employed in Culture, Media and Sports Occupations. For the purpose of drawing these diagrams, assume that the lowest gross weekly earnings are equal to the lowest decile and the highest gross weekly earnings are equal to the highest decile. *(4 marks)*

(e) Compare the distributions of the data revealed by your box and whisker plots. *(3 marks)*

END OF QUESTIONS

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