AQA

A-level
STATISTICS
Unit Statistics 6

Monday 27 June 2016   Morning   Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
● the blue AQA booklet of formulae and statistical tables.
You may use a graphics calculator.

Instructions
● Use black ink or black ball-point pen. Pencil should only be used for drawing.
● Fill in the boxes at the top of this page.
● Answer **all** questions.
● Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
● You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
● Do not write outside the box around each page.
● Show all necessary working; otherwise marks for method may be lost.
● Do all rough work in this book. Cross through any work that you do not want to be marked.
● The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information
● The marks for questions are shown in brackets.
● The maximum mark for this paper is 75.

Advice
● Unless stated otherwise, you may quote formulae, without proof, from the booklet.
● You do not necessarily need to use all the space provided.

Answer **all** questions.

Answer each question in the space provided for that question.

1 The length of time before the deadline when a piece of biochemistry coursework was handed in by each of 19 university students was recorded.

The mark, expressed as a percentage, that each student was subsequently awarded for their coursework was also recorded.

The results are summarised in the table.

Length of time before the deadline			
24 hours or more	12 hours or more but less than 24 hours	2 hours or more but less than 12 hours	Less than 2 hours
66.3	68.5	61.8	58.4
63.2	71.6	67.1	61.9
67.5	64.2	59.7	55.8
72.1	65.3	52.2	65.6
76.2	59.1	62.4	

(a) Carry out a one-factor analysis of variance, using the 5% level of significance, to investigate for a difference in mean mark awarded for the four different time categories.

[10 marks]

(b) State **two** assumptions that must be made about the given data in order for the analysis in part **(a)** to be valid.

[2 marks]

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2 One box each of two popular brands of chocolates, '*Quality Chox*' and '*Chok Delights*', was placed, for staff consumption, on each of 12 wards at a large UK hospital.

As part of an investigation into staff consumption of chocolates whilst at work, these boxes were kept under surveillance and the time at which each chocolate in each box was taken was recorded.

(a) The times taken, to the nearest minute, before the boxes were first opened after they had been placed on the wards, are given in **Table 1**.

Table 1

	Hospital ward											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Quality Chox	16	18	12	10	18	12	13	13	20	16	19	21
Chok Delights	11	18	8	7	19	13	9	11	12	12	10	19

Making any necessary assumptions, carry out a paired t-test, using the 5% level of significance, to investigate the belief that the time taken for a box of *Chok Delights* chocolates to be first opened after having been placed on a ward, is, on average, less than that for a box of *Quality Chox* chocolates.

[10 marks]

(b) Once a box had been opened, the length of time since opening, to the nearest minute, for each chocolate in the box to be taken was recorded.

For each box, the median of these times is given in **Table 2**.

Table 2

	Hospital ward											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Quality Chox	72	83	48	49	72	91	102	82	67	92	75	55
Chok Delights	56	52	49	61	35	45	72	36	52	48	36	22

Carry out a sign test, using the 1% level of significance, to investigate for any difference between the two brands of chocolates with respect to the average time since opening a box for a chocolate to be taken.

[6 marks]

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3 As part of an investigation into weight loss diets, sixteen men, all of whom were approximately 15 kilograms overweight, were chosen.

Four men were chosen randomly from each of the age groups 20–29 years, 30–39 years, 40–49 years and 50–59 years.

Each man within an age group was assigned at random to a different one of four types of diet, D1, D2, D3 and D4. Each diet provided exactly the same number of calories per day.

(a) (i) Identify the blocking factor for this investigation.

(ii) Identify the treatment factor for this investigation.

(iii) Explain the purpose of a blocking factor in such an investigation.

[4 marks]

(b) The weight loss achieved for each man in this investigation was recorded.

(i) Construct a fully labelled table that could be used to record the weight losses achieved by the men in this investigation.

(ii) State the type of experimental design used in this investigation.

(iii) Name the technique that you would use in order to analyse the data obtained from this investigation.

[6 marks]

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4   *Wonderful Wire Products* is a company specialising in the manufacture of metal springs.

The quality of production of a particular spring at this company is monitored by using a scoop to take samples of springs, at regular intervals, from the machine that manufactures them.

The results for 12 such samples are given in the table.

Sample	Number of springs in scoop	Number of non-conforming springs in scoop
1	67	10
2	55	7
3	75	10
4	71	15
5	66	20
6	62	10
7	58	11
8	67	10
9	60	9
10	72	13
11	68	9
12	59	6

(a)   Use these data to estimate n, the mean number of springs in a scoop, and show that an estimate of p, the proportion of non-conforming springs, is $\frac{1}{6}$.

[3 marks]

(b) (i)   Use the estimates from part **(a)** to calculate the upper 95% (warning) and upper 99.8% (action) control limits for a control chart for the proportion of springs in a scoop that are non-conforming.

[5 marks]

(ii)   On the grid on the page opposite, plot a control chart for the sample proportions of non-conforming springs.
On your chart, show the control limits calculated in part **(b)(i)** and the sample proportions for the 12 samples given in the table.

[4 marks]

(iii)   Comment on the current state of the manufacturing process of these springs.

[1 mark]

(c)   The following numbers of non-conforming springs were found in the next two samples.
Sample 13: 20 in a scoop of 69 springs
Sample 14: 19 in a scoop of 60 springs

For **each** of these samples, comment on the state of the production process and suggest any resulting action that may need to be taken.
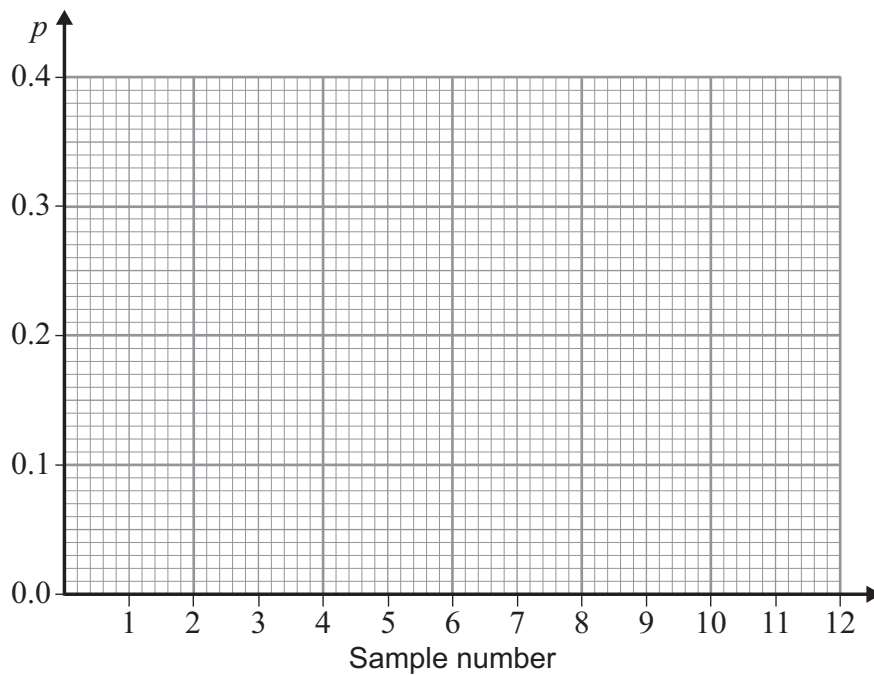
[5 marks]

QUESTION PART REFERENCE	Answer space for question 4

(b)(ii)

Axis: *p* from 0.0 to 0.4, Sample number from 1 to 12

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5 Mineral supplements, to be used for working camels aged 2 years to 8 years, are supplied in $10\,\text{kg}$ bags to camel owners.

The weights of these bags are known to be normally distributed with a standard deviation of $0.6\,\text{kg}$.

Before bags are delivered to customers, Amur, who manages a camel supplies business, selects bags at random from large batches and weighs the contents of each selected bag.

Amur initially proposes that a batch be accepted if the mean weight of the contents of a random sample of $n = 4$ bags exceeds $k = 9.8\,\text{kg}$.

(a) Complete the table, in the answer space below, for Amur's proposed sampling plan.

[4 marks]

(b) Amur and the camel owners decide that his initial proposal is unsatisfactory and therefore new values are required for n and k.

Amur decides that he requires that the probability of accepting a batch of bags with mean contents of $10.0\,\text{kg}$ should be at least 0.95 .

The camel owners decide that they require that the probability of accepting a batch of bags with mean contents of $9.4\,\text{kg}$ should be at most 0.01 .

Determine the minimum value of n and a corresponding value of k if both Amur's and the camel owners' requirements are to be met.

[6 marks]

QUESTION PART REFERENCE

Answer space for question 5

(a)

Mean weight of contents of 4 bags	9.2	9.4	9.6	9.8	10.0	10.2	10.4
Probability batch is accepted		0.091		0.5		0.909	

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6 Researchers wished to investigate the effect of background music on the output of workers performing a complex operation in rug manufacture.

Four music radio stations (A, B, C, D) and one non-music radio station (E) were played to the workers in the rug factory on each of the five days of the working week (M, Tu, W, Th, F) for each of five successive working weeks (1, 2, 3, 4, 5).

The mean hourly output was recorded for each day.

An analysis of the results is given in the table.

Source	Sum of squares
Between radio stations A, B, C, D, E	177.84
Between days of the working week M, Tu, W, Th, F	123.44
Between working weeks 1, 2, 3, 4, 5	11.84
Error	
Total	433.84

(a) Name the experimental design used for this investigation.

[1 mark]

(b) (i) Investigate for a difference in the mean hourly output between the five radio stations. Use the 1% level of significance.

[6 marks]

(ii) State the assumption that must be made regarding interactions of factors when carrying out the test in part **(b)(i)**, and explain its implications in the context of this question.

[2 marks]

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QUESTION PART REFERENCE	Answer space for question 6

END OF QUESTIONS