Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2011

Statistics SS06

Unit Statistics 6

Wednesday 22 June 2011 9.00 am to 10.30 am

For this paper you must have:
- the blue AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed
- 1 hour 30 minutes

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 the questions in the spaces provided. 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.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 A trial was carried out to investigate the effect of an antibiotic treatment for acute ear infections in children aged between 6 months and 2 years. A researcher gave the following description of the trial design.

'After we obtained consent the children were randomly assigned to treatment with amoxicillin or with a placebo suspension with the same colour and taste. The suspensions were supplied to the participating doctors in a double blind fashion with computerised two block randomisation; doctors, parents and investigators remained blinded throughout the study.'

Source: *British Medical Journal*, 2000

(a) Explain, in context, the meaning of:

(i) randomly assigned; *(1 mark)*

(ii) placebo; *(1 mark)*

(iii) double blind. *(1 mark)*

(b) Explain the purpose of:

(i) a placebo; *(1 mark)*

(ii) a double blind trial. *(1 mark)*

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2 As part of an investigation into prices, nine electrical items, A, B, C, D, E, F, G, H and I, were selected from those regularly sold at electrical stores.

Ten electrical stores were selected at random from those in Yorkshire and ten from those in Surrey.

The average prices, in £, for each of the nine electrical items from the stores in Yorkshire and from the stores in Surrey were found.

The average prices are given in the table.

Location \ Item	A	B	C	D	E	F	G	H	I
Yorkshire	26.01	1.99	27.12	12.86	121.53	14.94	11.30	13.23	4.79
Surrey	36.10	3.62	25.77	13.99	124.20	11.19	19.53	24.66	3.56

(a) Use a paired *t*-test to investigate the claim that the mean price of electrical items is lower in Yorkshire than it is in Surrey. Use the 5% level of significance. *(9 marks)*

(b) (i) What assumption about the distribution of the differences did you have to make in order for the test in part **(a)** to be valid? *(1 mark)*

(ii) If it was found that this assumption was not valid, suggest another test that could be carried out as an alternative to that carried out in part **(a)**.

Give a reason for your answer. *(2 marks)*

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3 A comparative study of the reading attainment of children aged around 10 years was carried out during 2006. The children involved were taught to read by one of three different methods: A, B or C.

The table gives the reading attainment score, on a scale established in 2001, for a random selection of these children, all of whom had undertaken at least four years of formal education.

A higher score indicates a higher level of reading attainment.

	Method A	**Method B**	**Method C**
Reading attainment score	513 498 457 448 439 502	542 497 501 493 457	429 465 480 466 425 493 432
Total	**2857**	**2490**	**3190**

$$\sum_i \sum_j x_{ij}^2 = 4\,067\,243$$

(a) Use a one-factor analysis of variance to investigate, at the 5% level of significance, for a difference between the three teaching methods. *(9 marks)*

(b) State **two** assumptions that you made in order to carry out the test in part **(a)**. *(2 marks)*

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4 A manufacturer produces wafers for use in the computer industry. Each wafer contains 50 chips in specific locations.

A wafer is said to have a 'misregistration' if it contains chips that are not at the correct distance from the centre. Wafers with a misregistration cannot be used.

At regular intervals during production, samples of 60 wafers are obtained and examined to find out how many of these have a misregistration.

During one day of satisfactory production, 8 samples, each of 60 wafers, were taken, with the results given in the table.

Sample	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Number with a misregistration	9	12	11	10	10	12	8	9

(a) Calculate upper and lower warning (95%) and action (99.8%) control limits for a chart for the proportion of wafers with a misregistration. *(8 marks)*

(b) State the action that you would recommend if the number of wafers with a misregistration in the next sample taken was:

(i) 20;

(ii) 16;

(iii) 3. *(5 marks)*

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5 A manufacturer of stainless steel shafts wishes to introduce an acceptance sampling plan and is advised to consider both single and double sampling plans.

The following three plans are suggested.

Single Sampling Plan R Take a sample of 30 shafts from each batch and accept the batch if no shafts are non-conforming in the sample; otherwise reject the batch.

Single Sampling Plan S Take a sample of 30 shafts from each batch and accept the batch if no more than one shaft is non-conforming in the sample; otherwise reject the batch.

Double Sampling Plan T Take a sample of 25 shafts from each batch. Accept the batch if no shafts are non-conforming in the sample. Reject the batch if two or more shafts are non-conforming in the sample. Otherwise take a further sample of 25 shafts from the batch and accept the batch if a total of two or fewer shafts are found to be non-conforming from the 50 shafts inspected.

(a) The table opposite shows some of the probabilities of accepting batches containing various percentages of non-conforming shafts for Plans R, S and T.

Complete the table. *(7 marks)*

(b) Sketch the operating characteristic for each of Plans R, S and T on the graph opposite. *(3 marks)*

(c) Hence estimate the probability that a batch containing:

(i) 4 per cent non-conforming shafts is accepted by Plan R; *(1 mark)*

(ii) 8 per cent non-conforming shafts is rejected by Plan T. *(1 mark)*

(d) If more than one out of seven successive batches of shafts are rejected, the manufacturer's customer will demand a more stringent inspection plan.

Find the probability of more than one out of the next seven successive batches being rejected when Plan S is used if the proportion non-conforming is 1 per cent. *(4 marks)*

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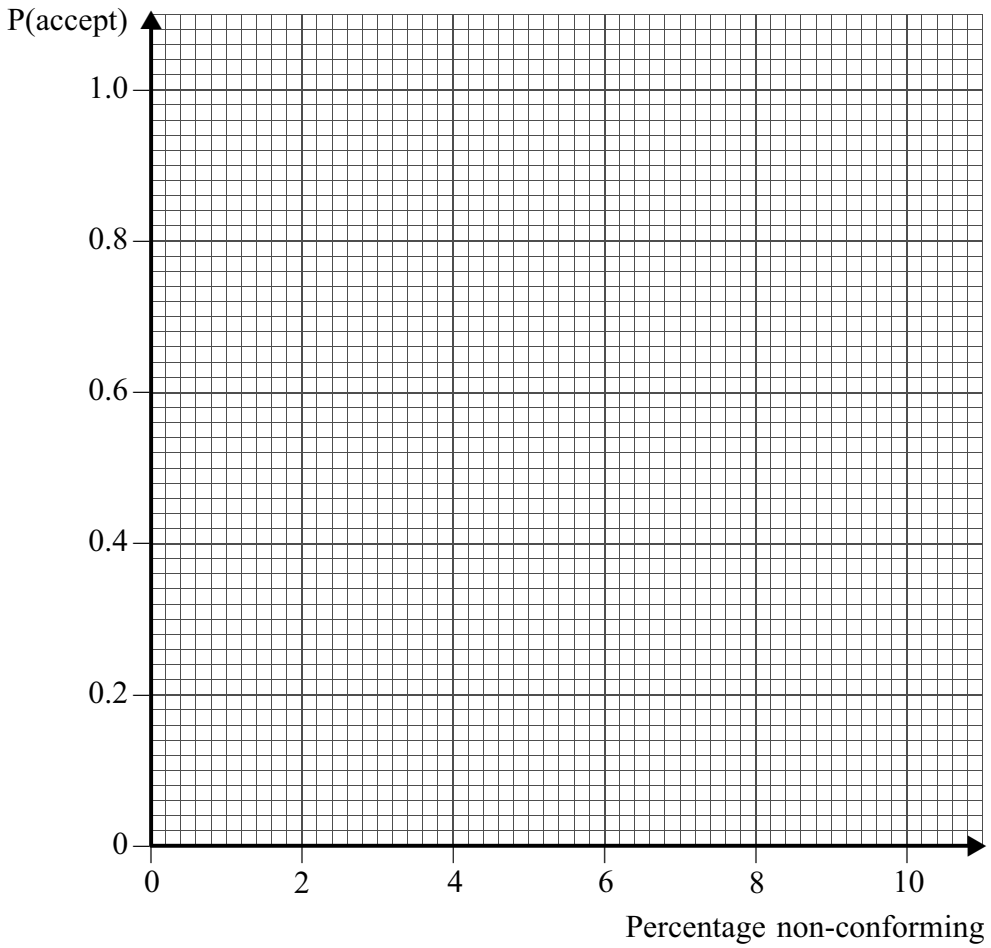
(a)

		Percentage non-conforming		
		1	**5**	**10**
P(accept)	**Plan R**		0.2146	
	Plan S	0.9639		
	Plan T	0.9692		0.1259

(b)



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6 An advertising agency was asked to promote a new brand of apple concentrate which, when mixed with water, produces apple juice. The agency wished to investigate four advertising approaches and three different types of media for this promotion.

The advertising approaches for the promotion of the new concentrate focused on its convenience, its quality, its cost or its health benefits.

Twelve towns of similar size and similar demographic make-up were selected for the launch of the promotion. Four of these towns were randomly allocated to advertising only on the local television station, four to advertising only in the local newspaper and four to advertising only on the local radio station.

The sales of the new concentrate were recorded for each town during the 10 weeks of the advertising campaign.

The average weekly numbers of bottles of the new concentrate sold are given in the table.

		Advertising approach			
		Convenience	**Quality**	**Cost**	**Health benefits**
Media type	**Television**	555.5	643.0	600.0	523.6
	Newspaper	575.9	687.1	624.4	573.8
	Radio	561.2	640.3	605.2	531.8

$$\sum_i \sum_j x_{ij} = T = 7121.8 \qquad \sum_i \sum_j x_{ij}^2 = 4\,253\,083.04$$

(a) (i) Carry out tests, using the 1% level of significance, to investigate for a difference between average weekly sales for the four advertising approaches and also for the three types of media. *(13 marks)*

(ii) Make a recommendation to the agency as to which advertising approach should be chosen. Give a reason for your choice. *(2 marks)*

(b) (i) State the assumption that you made regarding interaction of factors when carrying out your tests in part **(a)(i)**. *(1 mark)*

(ii) Explain your answer to part **(b)(i)** in the context of this question. *(2 marks)*

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END OF QUESTIONS

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