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For Examiner's Use	
Examiner's Initials	
Question	Mark
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2	
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TOTAL	



General Certificate of Education  
Advanced Level Examination  
June 2012

# Statistics

# SS04

## Unit Statistics 4

Thursday 14 June 2012 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 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.



J U N 1 2 S S 0 4 0 1

Answer **all** questions.

Answer each question in the space provided for that question.

**1** The number of vehicles arriving at a toll bridge between 10 am and midday may be modelled by a Poisson distribution. During a particular five-minute period between 10 am and midday, 86 vehicles arrived at the toll bridge.

Calculate an approximate 95% confidence interval for the mean number of vehicles arriving at the toll bridge during a five-minute period between 10 am and midday.

*(4 marks)*

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2 Giles persuaded 11 male students to allow him to measure the lengths of their bare left feet. The results, in centimetres, were as follows.

28.3 32.9 26.6 25.4 26.2 26.8 29.3 30.7 30.2 31.6 28.7

(a) Using the 5% significance level, test the hypothesis that the mean length of a male student’s left foot is 30.5 cm. The data may be assumed to be a random sample from a normal distribution. *(8 marks)*

(b) Use the data and the result of your test in part (a) to make **two** comments on the claim that, on average, a male student’s foot is one foot in length. (One foot in length is equal to 30.5 cm, correct to one decimal place.) *(2 marks)*

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3 In 1995, the Harwood Group carried out a survey in the USA on consumption, materialism and the environment.

(a) An analysis of the results showed that 21% of respondents either agreed or strongly agreed with the statement

*I would be much more satisfied with my life if I had a nicer car.*

Tambe, a student, decided to administer the questionnaire to a sample of adults in **England** and to compare the responses. She found that 22 of the 125 adults sampled in England either agreed or strongly agreed with the above statement.

Calculate an approximate 95% confidence interval for the proportion of adults in England who either agree or strongly agree with the statement. Regard the 125 adults as a random sample of adults in England. (5 marks)

(b) In the USA survey, 66% of respondents either agreed or strongly agreed with the statement

*I would be much more satisfied with my life if I were able to spend more time with my family and friends.*

Tambe found that 91 of the 125 adults sampled in **England** either agreed or strongly agreed with this second statement.

Calculate an approximate 95% confidence interval for the proportion of adults in England who either agree or strongly agree with this second statement. (2 marks)

(c) State, with a reason, whether your answers provide significant evidence of a difference between:

(i) the replies of respondents in the USA and in England to the statement in part (a);

(ii) the replies of respondents in the USA and in England to the statement in part (b);

(iii) the replies of respondents in England to the statements in parts (a) and (b).

(5 marks)

QUESTION PART REFERENCE

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**4** Michael is studying statistics and, during a lesson on distributional approximations, is set the following two tasks.

**Task A** Use a distributional approximation to estimate the probability that an observation from a binomial distribution with  $n = 400$  and  $p = 0.0075$  will be greater than 4.

**Task B** Use a distributional approximation to estimate the probability that an observation from a binomial distribution with  $n = 400$  and  $p = 0.75$  will be at least 290 but not exceed 305.

**(a) (i)** Carry out **Task A**. *(3 marks)*

**(ii)** Carry out **Task B**. *(6 marks)*

**(b)** Michael uses a graphics calculator and obtains the probabilities required in **Tasks A** and **B** directly, using an exact binomial distribution. These probabilities, correct to three decimal places, are as follows.

**Task A** 0.184  
**Task B** 0.622

Compare your answers with those obtained by Michael. *(2 marks)*

**(c)** Michael claims that there is no point in his learning how to use distributional approximations as he can obtain exact answers easily using a graphics calculator.

**(i)** Give an example of a statistical procedure where a normal approximation to a binomial distribution is commonly used. *(1 mark)*

**(ii)** Comment on Michael’s claim as it relates to a Poisson approximation to a binomial distribution. *(2 marks)*

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**5** In a bottling plant at a brewery, an amount,  $X$  grams, of beer is delivered into a bottle weighing  $Y$  grams. It is known that

$X$  is normally distributed with mean 509.0 and standard deviation 4.5;  
 $Y$  is normally distributed with mean 446.0 and standard deviation 5.6;  
 $X$  and  $Y$  are independent.

**(a)** Find the probability that:

- (i)** a bottle contains less than 500 grams of beer;
- (ii)** a bottle does not contain exactly 500 grams of beer;
- (iii)** the total weight of a bottle and the beer that it contains is more than 950 grams. *(7 marks)*

**(b)** A new bottling machine is installed which delivers beer into a bottle weighing  $Y$  grams until the total weight of the bottle and the beer that it contains reaches  $W$  grams. It is known that

$Y$  is normally distributed with mean 446.0 and standard deviation 5.6;  
 $W$  is normally distributed with mean 955.0 and standard deviation 6.2;  
 $Y$  and  $W$  are independent.

Find:

- (i)** the distribution of the weight of beer in a bottle; *(2 marks)*
- (ii)** the probability that a bottle contains less than 500 grams of beer. *(2 marks)*
- (c)** Give one disadvantage, in context, of using the new bottling machine. *(2 marks)*

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**6** The Geography department at a large comprehensive school offered optional classes during the Easter holidays to students who would be taking GCSE Geography in May. To be judged effective, these classes should lead to improved results. In previous years, 45% of students from this school who took GCSE Geography had achieved grade C or better.

- (a)** The first year that these classes were offered, 15 students chose to attend, and 9 of these students achieved grade C or better in GCSE Geography.

Use an exact test to examine whether there is evidence that the Easter-holiday classes were effective. Use the 5% significance level and assume that the 15 students may be regarded as a random sample of the school's GCSE Geography students.

*(5 marks)*

- (b)** The following year, 48 students chose to attend the classes. Of these students, 31 achieved grade C or better in GCSE Geography.

Use a distributional approximation and the 5% significance level to examine whether these Easter-holiday classes were effective. Assume that any necessary conditions are satisfied.

*(8 marks)*

- (c)** The 48 students mentioned in part **(b)** took a practice examination at the end of the Easter-holiday classes, and their marks had a mean of 55.75 and a standard deviation of 9.81.

- (i)** Calculate a 90% confidence interval for the mean mark that students would score in this practice examination if they attended the Easter-holiday classes. Assume that any necessary conditions are satisfied.
- (ii)** Before the Easter-holiday classes were offered, Geography students from this school taking a similar practice examination at the same time of year had achieved a mean mark of 54.2.

State whether there is significant evidence that the Easter-holiday classes were effective. Explain your answer.

*(5 marks)*

- (d) (i)** Summarise your conclusions from parts **(b)** and **(c)**. *(2 marks)*

- (ii)** Explain why, even if the pass rate and examination mean mark for the 48 students who attended the Easter-holiday classes had been much higher, the evidence for the effectiveness of the classes would **not** be conclusive. Your explanation should **not** include the possibility of a Type I error having been made. *(2 marks)*



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