General Certificate of Education
June 2008
Advanced Level Examination

STATISTICS **SS04**
Unit Statistics 4

Thursday 12 June 2008 9.00 am to 10.30 am

For this paper you must have:
- an 8-page answer book
- 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.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is SS04.
- Answer **all** questions.
- Show all necessary working; 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 75.
- The marks for questions are shown in brackets.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.

Answer **all** questions.

1 The proportion of blood donors who have blood group AB negative is 1 per cent.

(a) Specify the binomial distribution which describes the number of people who have blood group AB negative in a random sample of 120 blood donors. *(1 mark)*

(b) Use a Poisson approximation to estimate the probability that a random sample of 120 blood donors includes at least 4 people who have blood group AB negative. *(3 marks)*

2 Katrina is an athlete who competes in the 100 metres hurdles and in the long jump. At the start of one season, she set herself two targets to achieve in competitions during the season.

Target 1: Her mean time for the 100 metres hurdles will be less than 14.5 seconds.

Target 2: The probability that she fails to jump a distance of 5.5 metres or more with her first jump in a long jump competition will be less than 0.25.

(a) During the season, Katrina's times, in seconds, for the 100 metres hurdles in eight competitions were

14.2 14.6 13.9 14.4 14.6 14.5 14.3 14.1

Assuming that these times may be regarded as a random sample from a normal distribution, carry out a hypothesis test, at the 5% significance level, to investigate whether she achieved Target 1. *(9 marks)*

(b) During the season, Katrina failed to jump a distance of 5.5 metres or more with her first jump in 1 out of 15 long jump competitions.

Carry out a hypothesis test to investigate whether she achieved Target 2. Use an exact distribution and the 5% significance level. *(5 marks)*

3 Every spring, bluebell plants flower in a field. It has been found that the mean number of bluebell plants in one square metre of the field is 23 .

(a) (i) State **two** necessary conditions for the number of bluebell plants in one square metre of the field to be modelled by a Poisson distribution. *(2 marks)*

(ii) Assuming that the necessary conditions are satisfied, use a distributional approximation to find the probability that a square metre of the field contains fewer than 30 bluebell plants. *(5 marks)*

(b) The local council constructs a footpath next to the field. Roy, a local resident, is concerned about the possible effects of trampling, picking of bluebell flowers and digging up of bluebell plants. The footpath is opened at the beginning of a year. In the spring of the following year, Roy selects an area of 4 square metres in the field and finds a total of 79 bluebell plants inside this area. He claims that there has been a reduction in the number of bluebell plants per square metre of the field.

(i) Assuming that a Poisson model is still appropriate, construct an approximate 95% confidence interval for the mean number of bluebell plants per 4 square metres of the field. *(4 marks)*

(ii) Use your confidence interval to assess whether Roy's claim is justified. Assume that the area Roy examined was randomly selected from the field. *(3 marks)*

(iii) Give **two** reasons why the confidence interval that you constructed in part (b)(i) is approximate rather than exact. *(2 marks)*

Turn over for the next question

4 Patients who attend a particular clinic are prescribed drug A, which they must take over a long period of time. It is found that 25 per cent of them suffer stomach pains as a side effect of the drug. The consultant in charge of the clinic wants to investigate whether this side effect is equally likely to occur when an alternative drug, B, is taken.

The consultant prescribes drug B for 50 existing patients and 19 of them suffer stomach pains as a side effect.

(a) Construct an approximate 99% confidence interval for the proportion of patients taking drug B who suffer stomach pains as a side effect. Assume that the 50 patients given drug B are a random sample of existing patients. *(6 marks)*

(b) Use your confidence interval to assess whether patients are equally likely to suffer stomach pains as a side effect when taking drug B as they are when taking drug A. *(2 marks)*

(c) It is later found that the consultant had explained the purpose of the investigation to all existing patients, and had asked for volunteers to try drug B. Explain how, if at all, this information might affect the assessment that you made in part (b). *(2 marks)*

5 Many of the passengers who use a town bus route have travel passes which they must show to the driver, who then issues them with a ticket. Those who do not have travel passes must buy a ticket from the driver.

The time, X seconds, taken by the driver to serve a passenger who has a travel pass is normally distributed with mean 5.8 and standard deviation 1.4.

The time, Y seconds, taken by the driver to serve a passenger who does not have a travel pass is normally distributed with mean 18.5 and standard deviation 3.6.

At a particular bus stop, two passengers get on the bus. One of them has a travel pass and the other does not.

(a) Find the probability that the total time taken to serve the two passengers is less than 30 seconds. *(4 marks)*

(b) By considering the variable $Y - 3X$, find the probability that it takes more than three times as long to serve the passenger without a travel pass as it does to serve the passenger with a travel pass. *(7 marks)*

6 The Woodways Trust maintains a nature trail which is open to the public. There are two car parks next to the nature trail, and motorists using a car park are asked to place a donation in an 'honesty box'.

The Trust puts up a notice in each car park in an attempt to increase the total amount that it receives in donations from motorists.

The notice in car park A displays a photograph of a popular celebrity and says: '*Please give generously to support the Woodways Trust*'.

The notice in car park B says: '*Please support the Woodways Trust. Suggested donation: £1*'.

(a) Before the notices were put up, the proportion of motorists who made a donation was 40 per cent in both car parks.

(i) After the notice was put up in car park A, 33 out of a random sample of 60 motorists made a donation.

Carry out a hypothesis test, at the 5% significance level, to investigate whether the proportion of motorists using car park A who made a donation was more than 40 per cent. *(8 marks)*

(ii) After the notice was put up in car park B, 18 out of a random sample of 45 motorists made a donation. Explain why no hypothesis test is necessary to investigate whether the proportion of motorists using car park B who made a donation was more than 40 per cent. *(2 marks)*

(b) Before the notices were put up, the mean amount given by motorists who made a donation was 42 pence in each car park.

(i) After the notice was put up in car park A, the amounts, x pence, given by a random sample of 10 motorists who made a donation may be summarised as follows:

$$\bar{x} = 59.5 \qquad\qquad s = 19.21$$

Assuming that the amounts given by motorists using car park A who made a donation may be modelled by a normal distribution with mean μ, construct a 95% confidence interval for μ. *(4 marks)*

(ii) A 95% confidence interval for the mean amount, in pence, given by motorists who made a donation using car park B after the notice was put up was found to be (49.5, 76.3).

Use this information and your results from parts (a) and (b)(i) to compare the effectiveness of the two notices in increasing the **total** amount received by the Trust from car park donations. *(4 marks)*

(iii) Explain why a normal distribution is unlikely to be a suitable model for the amounts given by motorists using car park B who made a donation after the notice was put up. *(2 marks)*

END OF QUESTIONS

There are no questions printed on this page

There are no questions printed on this page

There are no questions printed on this page