

STATISTICS
Unit Statistics 4

SS04

Thursday 11 June 2009 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 An air ambulance is based at a hospital. There is a probability of 0.005 that, on any one day, there is a delay in the air ambulance leaving to deal with an emergency.
- (a) Assuming that the probability of a delay is independent from day to day, specify a distribution that might be used to model the number of days on which a delay occurs during a period of 200 days. *(1 mark)*
 - (b) Use a distributional approximation to find the probability that, during a period of 200 days, there are three or more days on which a delay occurs. *(3 marks)*
 - (c) Explain why the distributional approximation that you used in part (b) is appropriate. *(2 marks)*
- 2 Students on an environmental science course are investigating nitrate pollution in a river in an agricultural region. The level of pollution becomes a cause for concern when the mean concentration of nitrate exceeds 30 milligrams per litre of water.

The river is divided into a large number of sections of equal length.

- (a) One student takes samples of water at 8 randomly chosen locations along one of these sections and analyses the samples for nitrate concentration. Her results, in milligrams of nitrate per litre of water, are

30 34 34 37 28 30 34 35

Carry out a test to investigate whether the nitrate pollution in this section of the river is a cause for concern. Assume that the data are drawn from a normal population, and use the 1% significance level. *(8 marks)*

- (b) The students carry out similar investigations to that in part (a) on 42 sections. Their tests indicate that the mean concentration of nitrate exceeds 30 milligrams per litre of water in 16 sections.
- (i) Carry out a test, at the 1% significance level, to determine whether the level of nitrate concentration is a cause for concern in less than 60 per cent of sections of this river. *(7 marks)*
 - (ii) State **one** assumption that must be made for your conclusion in part (b)(i) to be valid. *(1 mark)*

- 3 There used to be a cash machine outside a village store. During the time the store was open, the number of people per hour who used the machine was modelled by a Poisson distribution with mean 13.5.

For security reasons, the machine was then moved inside the store. On a particular day after the machine was moved, 47 people used the machine during a 4-hour period.

- (a) Assuming that a Poisson distribution continues to be a suitable model, construct an approximate 90% confidence interval for the mean number of people using the machine during a 4-hour period when the store is open. (4 marks)
- (b) Comment on the suggestion that fewer people use the machine in its new location. (3 marks)

- 4 Yvonne was one of two candidates in a local election. On the day of the election, voters were interviewed as they left their polling stations and asked which candidate they had voted for.

From a random sample of 320 females, 188 said that they had voted for Yvonne.
From a random sample of 260 males, 117 said that they had voted for Yvonne.

- (a) Assuming that the answers given were truthful, construct an approximate 95% confidence interval for:
- (i) the proportion of females who voted for Yvonne;
- (ii) the proportion of males who voted for Yvonne. (7 marks)
- (b) State, with a reason, whether females were more likely than males to vote for Yvonne. (2 marks)
- (c) At the close of voting, Yvonne believed that she had won the election. Comment, with justifications, on her belief. (4 marks)

- 5 A company produces low-calorie sweetener tablets. Each tablet produced is sealed in a packet.

The weight, X milligrams, of a tablet is normally distributed with mean 110 and standard deviation 5.

The weight, Y milligrams, of an empty packet is normally distributed with mean 370 and standard deviation 12.

You may assume that X and Y are independent random variables.

- (a) Find the probability that the weight of a packet containing a tablet is less than 500 milligrams. (4 marks)
- (b) By considering the variable $Y - 3X$, find the probability that the weight of a packet is more than three times the weight of the tablet it contains. (7 marks)

Turn over ►

6 A short-stay car park in a shopping area has spaces marked out for 90 cars. A local councillor notices that there are always some vacant spaces. He puts forward a plan to create a garden and seating area using part of the car park. This would reduce the number of parking spaces to 78.

- (a) From a random sample of 14 users of the car park, 11 say that the car park will be too small if this plan is carried out. Carry out a test to determine whether more than half of the users of the car park think it will be too small. Use an exact distribution and the 5% significance level. *(6 marks)*
- (b) The number of occupied spaces, x , in the car park is recorded on each of 16 randomly chosen occasions during shopping hours. The results may be summarised as follows:

$$\bar{x} = 59.9 \quad s = 7.83$$

- (i) Construct a 95% confidence interval for the mean, μ , of the number of spaces occupied in the car park during shopping hours. Assume that the sample is drawn from a normal population. *(4 marks)*
- (ii) The councillor claims that the value of μ is no more than 65. State, with a reason, whether this claim is plausible. *(2 marks)*
- (c) It is found that the number of occupied spaces during shopping hours is best modelled by a Poisson distribution with mean μ .
- (i) Comment on the validity of your confidence interval found in part (b)(i). *(2 marks)*
- (ii) Taking μ to be 65, use a distributional approximation to find the probability that more than 78 spaces are occupied in the car park at any one time. *(4 marks)*
- (d) Use your results to explain whether or not the car park will be too small if the plan to create a garden and seating area is carried out. *(4 marks)*

END OF QUESTIONS