

General Certificate of Education  
January 2008  
Advanced Level Examination



**MATHEMATICS**  
**Unit Statistics 2B**

**MS2B**

Friday 11 January 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 blue or black ink or 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 MS2B.
- 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.
- Unit Statistics 2B has a **written paper only**.

**Advice**

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

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Answer **all** questions.

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- 1 David claims that customers have to queue at a supermarket checkout for more than 5 minutes, on average.

The queuing times,  $x$  minutes, of 40 randomly selected customers result in  $\bar{x} = 5.5$  and  $s^2 = 1.31$ .

Investigate, at the 1% level of significance, David's claim. (6 marks)

- 2 A new information technology centre is advertising places on its one-week residential computer courses.

- (a) The number of places,  $X$ , booked each week on the publishing course may be modelled by a Poisson distribution with a mean of 9.0.

(i) State the standard deviation of  $X$ . (1 mark)

(ii) Calculate  $P(6 < X < 12)$ . (3 marks)

- (b) The number of places booked each week on the web design course may be modelled by a Poisson distribution with a mean of 2.5.

(i) Write down the distribution for  $T$ , the **total** number of places booked each week on the publishing and web design courses. (1 mark)

(ii) Hence calculate the probability that, during a given week, a total of fewer than 2 places are booked. (3 marks)

- (c) The number of places booked on the database course during each of a random sample of 10 weeks is as follows:

14    15    8    16    18    4    10    12    15    8

By calculating appropriate numerical measures, state, with a reason, whether or not the Poisson distribution  $Po(12.0)$  could provide a suitable model for the number of places booked each week on the database course. (3 marks)

- 3 (a) The continuous random variable  $T$  follows a rectangular distribution with probability density function given by

$$f(t) = \begin{cases} k & -a \leq t \leq b \\ 0 & \text{otherwise} \end{cases}$$

- (i) Express  $k$  in terms of  $a$  and  $b$ . (1 mark)
- (ii) Prove, using integration, that  $E(T) = \frac{1}{2}(b - a)$ . (4 marks)
- (b) The error, in minutes, made by a commuter when estimating the journey time by train into London may be modelled by the random variable  $T$  with probability density function

$$f(t) = \begin{cases} \frac{1}{10} & -4 \leq t \leq 6 \\ 0 & \text{otherwise} \end{cases}$$

- (i) Write down the value of  $E(T)$ . (1 mark)
- (ii) Calculate  $P(T < -3 \text{ or } T > 3)$ . (2 marks)
- 4 A speed camera was used to measure the speed,  $V$  mph, of John's serves during a tennis singles championship.

For 10 randomly selected serves,

$$\sum v = 1179 \quad \text{and} \quad \sum (v - \bar{v})^2 = 1014.9$$

where  $\bar{v}$  is the sample mean.

- (a) Construct a 99% confidence interval for the mean speed of John's serves at this tennis championship, stating any assumption that you make. (7 marks)
- (b) Hence comment on John's claim that, at this championship, he consistently served at speeds in excess of 130 mph. (1 mark)

Turn over ►

5 A discrete random variable  $X$  has the probability distribution

$$P(X = x) = \begin{cases} \frac{x}{20} & x = 1, 2, 3, 4, 5 \\ \frac{x}{24} & x = 6 \\ 0 & \text{otherwise} \end{cases}$$

(a) Calculate  $P(X \geq 5)$ . (2 marks)

(b) (i) Show that  $E\left(\frac{1}{X}\right) = \frac{7}{24}$ . (2 marks)

(ii) Hence, or otherwise, show that  $\text{Var}\left(\frac{1}{X}\right) = 0.036$ , correct to three decimal places. (3 marks)

(c) Calculate the mean and the variance of  $A$ , the area of rectangles having sides of length  $X + 3$  and  $\frac{1}{X}$ . (5 marks)

6 A survey is carried out in an attempt to determine whether the salary achieved by the age of 30 is associated with having had a university education.

The results of this survey are given in the table.

	Salary < £30 000	Salary $\geq$ £30 000	Total
University education	52	78	130
No university education	63	57	120
Total	115	135	250

(a) Use a  $\chi^2$  test, at the 10% level of significance, to determine whether the salary achieved by the age of 30 is associated with having had a university education. (9 marks)

(b) What do you understand by a Type I error in this context? (2 marks)

- 7 The waiting time,  $X$  minutes, for fans to gain entrance to see an event may be modelled by a continuous random variable having the distribution function defined by

$$F(x) = \begin{cases} 0 & x < 0 \\ \frac{1}{2}x & 0 \leq x \leq 1 \\ \frac{1}{54}(x^3 - 12x^2 + 48x - 10) & 1 \leq x \leq 4 \\ 1 & x > 4 \end{cases}$$

- (a) (i) Sketch the graph of  $F$ . *(4 marks)*
- (ii) Explain why the value of  $q_1$ , the lower quartile of  $X$ , is  $\frac{1}{2}$ . *(2 marks)*
- (iii) Show that the upper quartile,  $q_3$ , satisfies  $1.6 < q_3 < 1.7$ . *(3 marks)*
- (b) The probability density function of  $X$  is defined by

$$f(x) = \begin{cases} \alpha & 0 \leq x \leq 1 \\ \beta(x-4)^2 & 1 \leq x \leq 4 \\ 0 & \text{otherwise} \end{cases}$$

- (i) Show that the **exact** values of  $\alpha$  and  $\beta$  are  $\frac{1}{2}$  and  $\frac{1}{18}$  respectively. *(5 marks)*
- (ii) Hence calculate  $E(X)$ . *(5 marks)*

**END OF QUESTIONS**

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