

General Certificate of Education  
June 2008  
Advanced Level Examination



**MATHEMATICS**  
**Unit Statistics 2A**

**MS2A/W**

Monday 2 June 2008 9.00 am to 10.15 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 15 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 MS2A/W.
- 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 60.
- The marks for questions are shown in brackets.
- Unit Statistics 2A has a **written paper and coursework**.

**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 It is thought that the incidence of asthma in children is associated with the volume of traffic in the area where they live.

Two surveys of children were conducted: one in an area where the volume of traffic was heavy and the other in an area where the volume of traffic was light.

For each area, the table shows the number of children in the survey who had asthma and the number who did not have asthma.

	Asthma	No asthma	Total
Heavy traffic	52	58	110
Light traffic	28	62	90
Total	80	120	200

- (a) Use a  $\chi^2$  test, at the 5% level of significance, to determine whether the incidence of asthma in children is associated with the volume of traffic in the area where they live. *(8 marks)*
- (b) Comment on the number of children in the survey who had asthma, given that they lived in an area where the volume of traffic was heavy. *(1 mark)*
- 2 (a) The number of genuine telephone calls,  $X$ , made to the emergency services each hour may be modelled by a Poisson distribution with mean 6.5.
- Determine the probability that, in a given hour, there will be fewer than 6 genuine telephone calls made to the emergency services. *(2 marks)*
- (b) The number of bogus telephone calls,  $Y$ , made to the emergency services each hour may be modelled by a Poisson distribution with mean 1.5.
- Calculate the probability that, in a given hour, there will be at least 1 bogus telephone call made to the emergency services. *(3 marks)*
- (c) Assuming that  $X$  and  $Y$  are independent Poisson variables, find:
- (i)  $P(X + Y = 6)$ ; *(3 marks)*
- (ii)  $P(Y \geq 1 | X < 6)$ . *(1 mark)*

- 3 Alan's company produces packets of crisps. The standard deviation of the weight of a packet of crisps is known to be 2.5 grams.

Alan believes that, due to the extra demand on the production line at a busy time of the year, the mean weight of packets of crisps is not equal to the target weight of 34.5 grams.

In an experiment set up to investigate Alan's belief, the weights of a random sample of 50 packets of crisps were recorded. The mean weight of this sample is 35.1 grams.

Investigate Alan's belief at the 5% level of significance. (6 marks)

- 4 The weight of fat in a digestive biscuit is known to be normally distributed.

Pat conducted an experiment in which she measured the weight of fat,  $x$  grams, in each of a random sample of 10 digestive biscuits, with the following results:

$$\sum x = 31.9 \quad \text{and} \quad \sum (x - \bar{x})^2 = 1.849$$

- (a) (i) Construct a 99% confidence interval for the mean weight of fat in digestive biscuits. (5 marks)
- (ii) Comment on a claim that the mean weight of fat in digestive biscuits is 3.5 grams. (2 marks)
- (b) If 200 such 99% confidence intervals were constructed, how many would you expect **not** to contain the population mean? (1 mark)

- 5 The management of the Wellfit gym claims that the mean cholesterol level of those members who have held membership of the gym for more than one year is 3.8.

A local doctor believes that the management's claim is too low and investigates by measuring the cholesterol levels of a random sample of 7 such members of the Wellfit gym, with the following results:

4.2      4.3      3.9      3.8      3.6      4.8      4.1

Is there evidence, at the 5% level of significance, to justify the doctor's belief that the mean cholesterol level is greater than the management's claim? State any assumption that you make. (8 marks)

- 6 (a) The number of text messages,  $N$ , sent by Peter each month on his mobile phone never exceeds 40.

When  $0 \leq N \leq 10$ , he is charged for 5 messages.

When  $10 < N \leq 20$ , he is charged for 15 messages.

When  $20 < N \leq 30$ , he is charged for 25 messages.

When  $30 < N \leq 40$ , he is charged for 35 messages.

The number of text messages,  $Y$ , that Peter is charged for each month has the following probability distribution:

$y$	5	15	25	35
$\mathbf{P}(Y = y)$	0.1	0.2	0.3	0.4

- (i) Calculate the mean and the standard deviation of  $Y$ . *(4 marks)*
- (ii) The Goodtime phone company makes a total charge for text messages,  $C$  pence, each month given by

$$C = 10Y + 5$$

Calculate  $E(C)$ . *(1 mark)*

- (b) The number of text messages,  $X$ , sent by Joanne each month on her mobile phone is such that

$$E(X) = 8.35 \quad \text{and} \quad E(X^2) = 75.25$$

The Newtime phone company makes a total charge for text messages,  $T$  pence, each month given by

$$T = 0.4X + 250$$

Calculate  $\text{Var}(T)$ . *(4 marks)*

7 The continuous random variable  $X$  has cumulative distribution function

$$F(x) = \begin{cases} 0 & x < -1 \\ \frac{x+1}{k+1} & -1 \leq x \leq k \\ 1 & x > k \end{cases}$$

where  $k$  is a positive constant.

(a) Find, in terms of  $k$ , an expression for  $P(X < 0)$ . *(2 marks)*

(b) (i) Show that the probability density function of  $X$  is defined by

$$f(x) = \begin{cases} \frac{1}{k+1} & -1 \leq x \leq k \\ 0 & \text{otherwise} \end{cases} \quad (2 \text{ marks})$$

(ii) Sketch the graph of  $f$ . *(2 marks)*

(c) Given that  $\text{Var}(X) = [E(X)]^2$ , show that  $k = 2 \pm \sqrt{3}$ . *(5 marks)*

**END OF QUESTIONS**

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