

General Certificate of Education
January 2005
Advanced Level Examination



MATHEMATICS (SPECIFICATION A)
Unit Statistics 1

MAS1/W

Tuesday 25 January 2005 Morning Session

In addition to this paper you will require:

- an 8-page answer book;
- the AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 20 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 MAS1/W.
- Answer **all** questions.
- All necessary working should be shown; 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.
- Tie loosely any additional sheets you have used to the back of your answer book before handing it to the invigilator.

Information

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.

Advice

- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

1 Each morning, Mustafa either cycles or walks to school.

- (a) The time, X minutes, taken by Mustafa to cycle to school may be modelled by a normal random variable with mean 12 and standard deviation 2.5.

Determine:

- (i) $P(X < 15)$; *(2 marks)*
- (ii) $P(10 < X < 15)$. *(3 marks)*
- (b) On each of a random sample of 50 mornings, Mustafa records his time, y minutes, to walk to school. From his recordings, Mustafa calculates the following quantities, where \bar{y} denotes the sample mean.

$$\sum y = 835.0 \qquad \sum (y - \bar{y})^2 = 533.61$$

- (i) Construct a 99% confidence interval for the mean time taken by Mustafa to walk to school. *(6 marks)*
- (ii) Mustafa suspects that, on average, the time he takes to walk to school is more than 25% longer than the time he takes to cycle to school.

State, with reasons, whether this suspicion is supported by your confidence interval. *(3 marks)*

2 An organisation has designed a questionnaire on health and safety which is to be distributed to a sample of 100 of its 1050 employees. Of these employees, 63 are management grades, 672 are professional grades and the remainder are administrative grades.

- (a) Steve, the Safety Adviser, suggests selecting 100 employees at random from all the employees.

Write down the name for this method of selecting a random sample. *(1 mark)*

- (b) Eddie, the Senior Health & Safety Adviser, suggests selecting 100 employees at random in such a way that the proportions of different grades of employee in the sample are the same as those for all employees.

- (i) Write down the name for this method of selecting a random sample. *(1 mark)*

- (ii) Determine the number of employees to be sampled from **each** of the three grades. *(2 marks)*

- (iii) Describe how Eddie can use random numbers to select the sample of management grade employees. *(3 marks)*

- (iv) To illustrate your method in part (b)(iii), use Table 13 in the formulae booklet supplied. Starting at the **first column** of the **second row**, and **working across the row**, identify the sample of management grade employees. *(2 marks)*

3 A company manufactures coloured drawing pins of which 20 per cent are yellow. The drawing pins are packed in boxes of 1000 and the contents of a box may be assumed to be a random sample.

- (a) (i) Specify a probability model for Y , the number of yellow drawing pins in a box. *(1 mark)*

- (ii) Use a distributional approximation to estimate $P(Y \geq 225)$. *(6 marks)*

- (b) The random variable U denotes the number of drawing pins selected from a box, without replacement, until 50 yellow drawing pins are obtained.

Give **two** reasons, in context, why U **cannot** be modelled by a binomial distribution.

(2 marks)

- 4 A machine cuts lengths of water hose for washing machines. Each length cut is at least 2 metres. The extra length, X millimetres, above 2 metres may be modelled by the following probability density function, where c is a positive constant.

$$f(x) = \begin{cases} c & 0 \leq x \leq 4 \\ \frac{c}{16}(20 - x) & 4 \leq x \leq 20 \\ 0 & \text{otherwise} \end{cases}$$

- (a) Sketch the graph of f . *(4 marks)*
- (b) By considering your sketch, or otherwise, find the exact value of c . *(3 marks)*
- (c) Hence determine the probability that a randomly selected length of hose is less than 2.01 metres. *(4 marks)*
- 5 The probability that Janet receives at least one e-mail message on any day is 0.85. The number of messages received may be considered independent from day to day.
- (a) Calculate the probability that, during a 16-day period, Janet receives at least one e-mail message on exactly 12 days. *(3 marks)*
- (b) Determine the probability that, during a 30-day period, Janet receives at least one e-mail message on more than 21 days but fewer than 28 days. *(4 marks)*

- 6 The discrete random variable X has

$$E(X) = 4 \quad \text{and} \quad E(X^2) = 17.2.$$

- (a) Find the value of $\text{Var}(X)$. *(2 marks)*
- (b) A circle has radius $(X + 8)$.

Find, in terms of π , values for the mean and variance of the **circumference**, C , of the circle. *(4 marks)*

- (c) The **area**, S , of the circle, with radius $(X + 8)$, is to be expressed in the form

$$\pi(X^2 + aX + b),$$

where a and b are positive constants.

- (i) Find values for a and b . *(2 marks)*
- (ii) Hence find, in terms of π , the value of $E(S)$. *(2 marks)*

END OF QUESTIONS