General Certificate of Education
June 2009
Advanced Level Examination

MATHEMATICS **MS03**
Unit Statistics 3

Friday 19 June 2009 1.30 pm to 3.00 pm

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 MS03.
- 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 analysis of a random sample of 150 urban dwellings for sale showed that 102 are semi-detached.

An analysis of an independent random sample of 80 rural dwellings for sale showed that 36 are semi-detached.

(a) Construct an approximate 99% confidence interval for the difference between the proportion of urban dwellings for sale that are semi-detached and the proportion of rural dwellings for sale that are semi-detached. *(6 marks)*

(b) Hence comment on the claim that there is no difference between these two proportions. *(2 marks)*

2 A hotel chain has hotels in three types of location: city, coastal and country. The percentages of the chain's reservations for each of these locations are 30, 55 and 15 respectively.

Each of the chain's hotels offers three types of reservation: Bed & Breakfast, Half Board and Full Board.

The percentages of these types of reservation for **each** of the three types of location are shown in the table.

		Type of location		
		City	**Coastal**	**Country**
Type of reservation	**Bed & Breakfast**	80	10	30
	Half Board	15	65	50
	Full Board	5	25	20

For example, 80 per cent of reservations for hotels in city locations are for Bed & Breakfast.

(a) For a reservation selected at random:

(i) show that the probability that it is for Bed & Breakfast is 0.34; *(2 marks)*

(ii) calculate the probability that it is for Half Board in a hotel in a coastal location; *(2 marks)*

(iii) calculate the probability that it is for a hotel in a coastal location, given that it is for Half Board. *(4 marks)*

(b) A random sample of 3 reservations for Half Board is selected.

Calculate the probability that these 3 reservations are for hotels in different types of location. *(5 marks)*

3 The proportion, p, of an island's population with blood type A Rh^+ is believed to be approximately 0.35.

A medical organisation, requiring a more accurate estimate, specifies that a 98% confidence interval for p should have a width of at most 0.1.

Calculate, to the nearest 10, an estimate of the minimum sample size necessary in order to achieve the organisation's requirement. *(6 marks)*

4 Holly, a horticultural researcher, believes that the mean height of stems on Tahiti daffodils exceeds that on Jetfire daffodils by more than 15 cm.

She measures the heights, x centimetres, of stems on a random sample of 65 Tahiti daffodils and finds that their mean, $\bar{x}$, is 40.7 and that their standard deviation, s_x, is 3.4.

She also measures the heights, y centimetres, of stems on a random sample of 75 Jetfire daffodils and finds that their mean, $\bar{y}$, is 24.4 and that their standard deviation, s_y, is 2.8.

Investigate, at the 1% level of significance, Holly's belief. *(8 marks)*

5 The random variable X has a binomial distribution with parameters n and p.

(a) Given that

$$\mathrm{E}(X) = np \quad \text{and} \quad \mathrm{E}(X(X-1)) = n(n-1)p^2$$

find an expression for $\mathrm{Var}(X)$. *(3 marks)*

(b) Given that X has a mean of 36 and a standard deviation of 4.8:

(i) find values for n and p; *(3 marks)*

(ii) use a distributional approximation to estimate $\mathrm{P}(30 < X < 40)$. *(4 marks)*

6 The table shows the probability distribution for the number of weekday (Monday to Friday) morning newspapers, X, purchased by the Reed household per week.

x	0	1	2	3	4	5
$\mathbf{P}(X=x)$	0.16	0.15	0.25	0.25	0.15	0.04

(a) Find values for $\mathrm{E}(X)$ and $\mathrm{Var}(X)$. *(3 marks)*

(b) The number of weekday (Monday to Friday) evening newspapers, Y, purchased by the same household per week is such that

$$\mathrm{E}(Y) = 2.0, \quad \mathrm{Var}(Y) = 1.5 \quad \text{and} \quad \mathrm{Cov}(X, Y) = -0.43$$

Find values for the mean and variance of:

(i) $S = X + Y$;

(ii) $D = X - Y$. *(5 marks)*

(c) The total cost per week, L, of the Reed household's weekday morning and evening newspapers may be assumed to be normally distributed with a mean of £2.31 and a standard deviation of £0.89.

The total cost per week, M, of the household's weekend (Saturday and Sunday) newspapers may be assumed to be independent of L and normally distributed with a mean of £2.04 and a standard deviation of £0.43.

Determine the probability that the total cost per week of the Reed household's newspapers is more than £5. *(5 marks)*

7 The daily number of customers visiting a small arts and crafts shop may be modelled by a Poisson distribution with a mean of 24.

(a) Using a distributional approximation, estimate the probability that there was a total of at most 150 customers visiting the shop during a given 6-day period. *(5 marks)*

(b) The shop offers a picture framing service. The daily number of requests, Y, for this service may be assumed to have a Poisson distribution.

Prior to the shop advertising this service in the local free newspaper, the mean value of Y was 2. Following the advertisement, the shop received a total of 17 requests for the service during a period of 5 days.

(i) Using a Poisson distribution, carry out a test, at the 10% level of significance, to investigate the claim that the advertisement increased the mean daily number of requests for the shop's picture framing service. *(5 marks)*

(ii) Determine the critical value of Y for your test in part (b)(i). *(3 marks)*

(iii) Hence, assuming that the advertisement increased the mean value of Y to 3, determine the power of your test in part (b)(i). *(4 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