General Certificate of Education
January 2004
Advanced Subsidiary Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B)
Unit Statistics 2

MBS2

ASSESSMENT and QUALIFICATIONS ALLIANCE

Wednesday 14 January 2004 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 15 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 MBS2.
- 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.

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 The table below shows the average monthly production, in thousands, of a certain component, for the years 1990 – 2000.

Some values of the 5-point moving average and all values of an n-point moving average are given.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Average monthly production of component	47.2	33.8	40.4	41.9	36.1	35.4	29.8	36.0	39.0	38.5	31.2
5-point moving average			c	37.5	36.7	35.8	d	35.7	34.9		
***n*-point moving average**				37.8	36.2	36.9	36.7	35.1			

(a) Calculate the values of c and d. *(3 marks)*

(b) Write down the value of n. *(1 mark)*

2 The time series shown in **Figure 1** exhibits random variation about an upward linear trend.

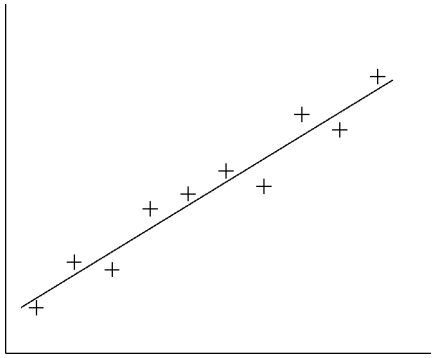
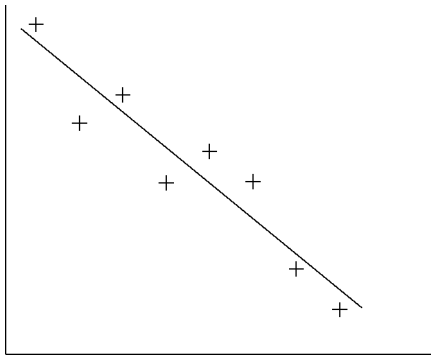


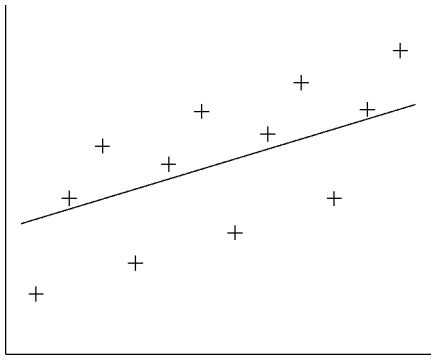
Figure 1

Describe the type of variation and trend for each of the time series below.

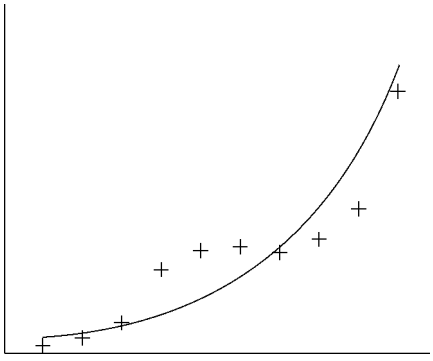
(a)



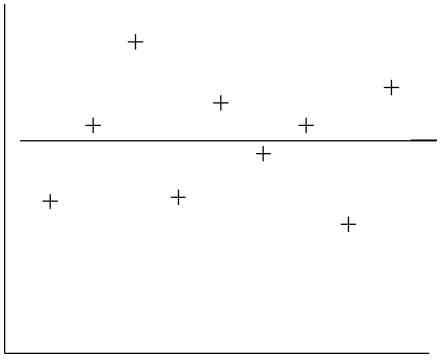
(b)



(c)



(d)



(8 marks)

3 Stocks are the stores of goods held by an organisation. The main purpose of stocks is to act as a buffer between supply and demand. The associated costs can be high. Stock control seeks to determine policies which will minimise these costs.

A fixed quantity (the *Economic Order Quantity*) of each item is ordered whenever the stock of that item falls to a predetermined level (the *Reorder Level*).

Reorder Cost is the cost of placing an order for an item.

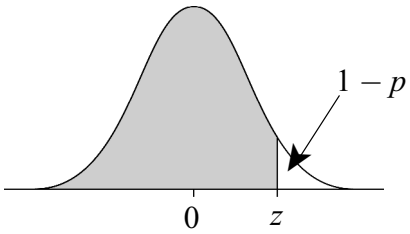
Holding Cost is the cost of storing one unit of an item for one unit of time.

Lead Time is the time between placing an order and receiving the stock.

To ensure that the probability of running out of stock before an order arrives is not more than $1 - p$, a *Safety Stock* is held.

$$Safety\ Stock = z\sigma\sqrt{Lead\ Time}$$

where σ is the standard deviation of the weekly demand and z is a value of the standard normal variable, as shown in the diagram below.



Given certain assumptions, the stock holding costs will be minimised when

$$Economic\ Order\ Quantity = \sqrt{\frac{2 \times Reorder\ Cost \times Demand}{Holding\ Cost}}$$

and

$$Reorder\ Level = Mean\ demand\ during\ Lead\ Time + Safety\ Stock$$

Weekly demand for fans for electrical heaters is normally distributed with mean 300 and standard deviation 40.
Reorder Cost is £200.
Holding Cost is £6 per fan per year.
Lead Time is fixed at 3 weeks.

(a) (i) Find the mean annual demand for fans. Assume a 52 week year. *(1 mark)*

(ii) Hence calculate the *Economic Order Quantity*, giving your answer to the nearest integer. *(3 marks)*

(b) (i) Calculate the amount of *Safety Stock* required to ensure that the probability of running out is not more than 0.05. *(3 marks)*

(ii) Hence calculate the *Reorder Level*, giving your answer to the nearest integer. *(3 marks)*

(c) Find the annual cost of holding the *Safety Stock*. *(2 marks)*

(d) Using your previous answers, copy and complete the following statement:

"The best policy is to order _____ fans whenever stock declines to _____ fans.

On average, orders should arrive when there are _____ fans remaining." *(3 marks)*

4 Accidents in a food processing plant which result in an insurance claim occur independently and at random.

The insurance company received the following number of claims from the food processing plant each week over a twelve-week period:

2 1 3 2 0 3 0 1 2 2 0 0

(a) Name the probability distribution for the number of claims per week. *(1 mark)*

(b) Calculate an approximate 98% confidence interval for the mean number of claims per week. *(6 marks)*

(c) Give **two** reasons why the confidence interval calculated in part (b) is approximate rather than exact. *(2 marks)*

TURN OVER FOR THE NEXT QUESTION

5 (a) Saucepans are manufactured by a machine. It is known that imperfect saucepans occur at random with a probability of 0.001.

(i) A random sample of 500 saucepans is taken. State the probability distribution for the number of imperfect saucepans in the sample. *(1 mark)*

(ii) Use an appropriate distributional approximation to estimate the probability that a batch of 500 saucepans contains 2 or more imperfect saucepans. *(3 marks)*

(b) The lids for the saucepans are manufactured by another machine. The number of imperfect lids manufactured may be modelled by a Poisson distribution with mean 30 per day.

Use a distributional approximation to estimate the probability of obtaining more than 250 but less than 260 imperfect lids during an **eight**-day period. *(7 marks)*

6 A university is hosting a summer school for 2000 students. All the students are accommodated in Halls of Residence on the campus. An administrator has been asked to conduct a survey to measure satisfaction with the quality of life on campus. A sample of students is to be obtained.

(a) The administrator has an alphabetical listing of the names of all 2000 students and they are numbered, consecutively, from 0000 to 1999. A number between 0 and 24, inclusive, is selected at random. The corresponding student and every 25th student thereafter is included in the sample.

(i) What is the name given to this method of sampling? *(1 mark)*

(ii) Write down the size of the sample that will be obtained. *(1 mark)*

(iii) Give an advantage of using this method of sampling rather than simple random sampling. *(1 mark)*

(b) The following table contains a breakdown of the students by gender and year of study.

Gender	Year 1	Year 2	Year 3	Year 4	Total
Female	360	260	240	240	1100
Male	280	240	200	180	900
Total	640	500	440	420	2000

A stratified random sample of size 100 is required.

(i) Construct a table as above to indicate the appropriate number of males and females from each year of study to include in the sample. *(3 marks)*

(ii) State, with a reason, whether the sample will be a simple random sample of the 2000 students. *(1 mark)*

(c) The 2000 students are accommodated in 20 Halls of Residence. Each Hall of Residence accommodates 100 students. The students are fully integrated by gender and year of study in each Hall of Residence.

Describe how random numbers could be used to obtain a cluster sample of size 200. *(6 marks)*

END OF QUESTIONS