



Rewarding Learning

ADVANCED

General Certificate of Education

2019

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# Mathematics

Assessment Unit S4

*assessing*

Module S2: Statistics 2



AMS41

[AMS41]

FRIDAY 14 JUNE, AFTERNOON

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## TIME

1 hour 30 minutes.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided.

Answer **all eight** questions.

Show clearly the full development of your answers.

Answers should be given to three significant figures unless otherwise stated.

You are permitted to use a graphic or scientific calculator in this paper.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 75

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A copy of the **Mathematical Formulae and Tables booklet** is provided.

Throughout the paper the logarithmic notation used is  $\ln z$  where it is noted that  $\ln z \equiv \log_e z$

**Answer all eight questions.**

**Show clearly the full development of your answers.**

**Answers should be given to three significant figures unless otherwise stated.**

**Normal and t-distribution values should be read from the tables provided.**

- 1** For the following case give **four** reasons to explain why the sampling procedure may not give a simple random sample.

The population is the owners of electric cars in Bangor.

The researcher acquires the addresses of all purchasers of electric cars from the car dealerships in the Bangor area over the last three years. He sends a mail drop to all Bangor purchasers asking them to participate in a survey. He decides that the first 25 responders who agree to be involved will constitute the sample. [4]

- 2** James the greengrocer sells his cooking apples in bags of 5. The masses of the apples,  $X$  grams, are independently normally distributed with mean 200 g and variance  $25 \text{ g}^2$ . The average mass of the 5 apples in the bag is modelled by the random variable  $\bar{X}_5$ .

**(i)** Write down the mean and variance of  $\bar{X}_5$ . [2]

A bag is chosen at random.

**(ii)** Find the probability that the average mass of the apples in the bag is greater than 198 g. [4]

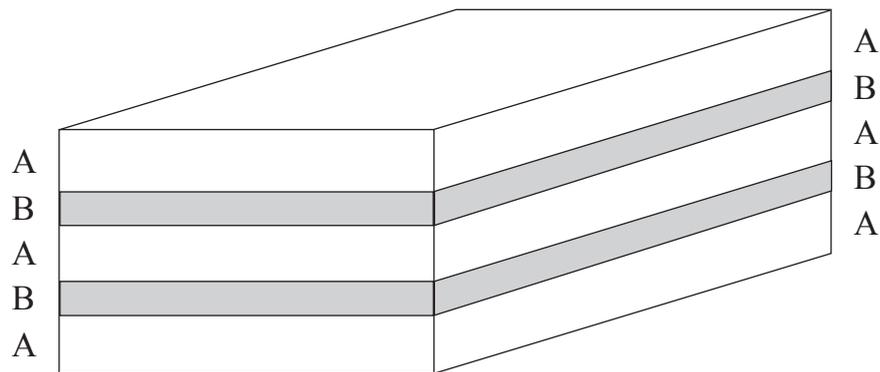
- 3** A Christmas tree producer measures the heights of a random sample of 100 trees from his tree farm. On the basis of this data he found that the 95% confidence interval for the mean height in centimetres of the trees was (159.02, 160.98).

Find the values of the mean and standard deviation of the sample. [6]

- 4** Regular user Liam suspects that the 8.00 am bus from Downpatrick to Belfast takes longer than the 60 minutes advertised. He records the times of his next 50 journeys. These produced a mean of 62.8 minutes and a standard deviation of 13.2 minutes.

Carry out a suitable test at the 5% level to determine whether his suspicion is justified. [7]

- 5 A laminated sheet consists of three layers of material A separated by two layers of material B. Each layer is in close contact with those adjacent. **Fig. 1** below shows a section of a sheet of the material.



**Fig. 1**

The thicknesses of all the layers are independent normally distributed random variables.

Each layer of A has a mean thickness of 40 mm and variance of  $0.07 \text{ mm}^2$

Each layer of B has a mean thickness of 25 mm and variance of  $0.02 \text{ mm}^2$

The sheets are only acceptable if their total thickness is between 169.2 mm and 170.8 mm.

- (i) Find the probability that a sheet is acceptable. [6]

Each sheet costs £6 to manufacture. Acceptable sheets are sold for £10 each while unacceptable sheets fetch £1 each for scrap.

- (ii) Calculate the expected profit per sheet. [2]

- 6 (a) A random variable  $X$  is such that  $X \sim N(30, 16)$ .

Find:

(i)  $P(3X > 100)$  [6]

(ii)  $P(X_1 + X_2 + X_3 > 100)$ , where  $X_1, X_2, X_3$  are independent observations from  $X$ . [6]

- (b) The retirement age  $X$  years of workers in a large company is a continuous random variable with mean 63.2 and variance 20  
A random sample of 80 retirees was taken in 2017

Find the probability that the sample mean is less than 62.5 [5]

- 7 A city council claims that a new traffic system will not change the times taken by city centre workers who cycle to work each morning. Before putting the system into operation, 10 randomly chosen city centre cyclists were asked to record the average time in minutes for their morning journey over a normal week.

After the new system was introduced the same 10 cyclists were asked to record over a similar week the average time it now takes to come to work by the same route.

The times in minutes are recorded in **Table 1** below.

**Table 1**

Cyclist	A	B	C	D	E	F	G	H	I	J
Before in minutes	25	36	50	40	27	41	18	32	44	28
After in minutes	20	32	46	35	28	46	15	25	39	32

Test, at the 5% significance level, whether the claim of “no change in journey time” is justified.

[12]

- 8 Happy Hours Toy Company produces toys for children. Olivia, a company director, records the numbers of a toy ship produced to order each week over an eight-week period together with their production costs for that week. **Table 2** below shows the data collected over the eight weeks.

**Table 2**

Number of Ships	$x$	21	33	31	29	18	25	36	22
Production Costs in £	$y$	80	106	103	100	60	90	112	76

Summary values of the data are:

$$\begin{array}{lll}
 n = 8 & \sum x = 215 & \sum y = 727 \\
 \sum x^2 = 6061 & \sum y^2 = 68265 & \sum xy = 20305
 \end{array}$$

- (i) Find the product moment correlation coefficient between  $x$  and  $y$ . [4]

A scatter diagram drawn by Olivia showed that the points  $(x, y)$  lie fairly closely to a straight line and so she decided that she would find an equation for the regression line of  $y$  on  $x$ .

- (ii) Find an equation for the regression line of  $y$  on  $x$  in the form  $y = a + bx$ . [7]

The selling price of a toy ship is £4.00

- (iii) Find the level of toy ship production at which the income and production costs are equal. Interpret this value. [4]

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**THIS IS THE END OF THE QUESTION PAPER**

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