

# Cambridge International AS & A Level

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## MATHEMATICS

**9709/63**

Paper 6 Probability &amp; Statistics 2

May/June 2022

**1 hour 15 minutes**

You must answer on the question paper.

You will need: List of formulae (MF19)

## INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

## INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

- 1** The number of characters in emails sent by a particular company is modelled by the distribution  $N(1250, 480^2)$ .

Find the probability that the mean number of characters in a random sample of 100 emails sent by the company is more than 1300. [3]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 2 Anton believes that 10% of students at his college are left-handed. Aliya believes that this is an underestimate. She plans to carry out a hypothesis test of the null hypothesis  $p = 0.1$  against the alternative hypothesis  $p > 0.1$ , where  $p$  is the actual proportion of students at the college that are left-handed. She chooses a random sample of 20 students from the college. She will reject the null hypothesis if at least 5 of these students are left-handed.

- (a) Explain what is meant by a Type I error in this context. [1]

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- (b) Find the probability of a Type I error in the test. [3]

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- (c) Given that the true value of  $p$  is 0.3, find the probability of a Type II error in the test. [2]

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- 3** Batteries of type *A* are known to have a mean life of 150 hours. It is required to test whether a new type of battery, type *B*, has a shorter mean life than type *A* batteries.

- (a) Give a reason for using a sample rather than the whole population in carrying out this test. [1]

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A random sample of 120 type  $B$  batteries are tested and it is found that their mean life is 147 hours, and an unbiased estimate of the population variance is 225 hours<sup>2</sup>.

- (b)** Test, at the 2% significance level, whether type *B* batteries have a shorter mean life than type *A* batteries. [5]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dotted lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

- (c) Calculate a 94% confidence interval for the population mean life of type *B* batteries. [3]

[illegible]

- 4 Each box of Seeds & Raisins contains  $S$  grams of seeds and  $R$  grams of raisins. The weight of a box, when empty, is  $B$  grams.  $S$ ,  $R$  and  $B$  are independent random variables, where  $S \sim N(300, 45)$ ,  $R \sim N(200, 25)$  and  $B \sim N(15, 4)$ . A full box of Seeds & Raisins is chosen at random.

(a) Find the probability that the total weight of the box and its contents is more than 500 grams. [5]

[illegible]

- (b) Find the probability that the weight of seeds in the box is less than 1.4 times the weight of raisins in the box. [5]

[illegible]

- 5** The number of clients who arrive at an information desk has a Poisson distribution with mean 2.2 per 5-minute period.

- (a) Find the probability that, in a randomly chosen 15-minute period, exactly 6 clients arrive at the desk. [3]

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- (b) If more than 4 clients arrive during a 5-minute period, they cannot all be served.

Find the probability that, during a randomly chosen 5-minute period, not all the clients who arrive at the desk can be served. [2]

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- (c) Use a suitable approximating distribution to find the probability that, during a randomly chosen 1-hour period, fewer than 20 clients arrive at the desk. [4]

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- 6 A random sample of 5 values of a variable  $X$  is given below.

2      3      3      5       $a$

- (a) Find an expression, in terms of  $a$ , for the mean of these values. [1]

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It is given that an unbiased estimate of the population variance of  $X$ , using these values, is 4. It is also given that  $a$  is positive.

- (b) Find and simplify a quadratic equation in terms of  $a$  and hence find the value of  $a$ . [3]

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- 7 The random variables  $X$  and  $W$  have probability density functions  $f$  and  $g$  defined as follows:

$$f(x) = \begin{cases} p(a^2 - x^2) & 0 \leq x \leq a, \\ 0 & \text{otherwise,} \end{cases}$$

$$g(w) = \begin{cases} q(a^2 - w^2) & -a \leq w \leq a, \\ 0 & \text{otherwise,} \end{cases}$$

where  $a$ ,  $p$  and  $q$  are constants.

- (a) (i) Write down the value of  $P(X \geq 0)$ . [1]

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- (ii) Write down the value of  $P(W \geq 0)$ . [1]

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- (iii) Write down an expression for  $q$  in terms of  $p$  only. [1]

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(b) Given that  $E(X) = 3$ , find the value of  $a$ .

[6]

[illegible]

[illegible]



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