



Oxford Cambridge and RSA

Thursday 13 June 2019 – Afternoon

A Level Further Mathematics A

Y542/01 Statistics

Time allowed: 1 hour 30 minutes



You must have:

- Printed Answer Booklet
- Formulae A Level Further Mathematics A

You may use:

- a scientific or graphical calculator

INSTRUCTIONS

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.** If additional space is required, you should use the lined page(s) at the end of the Printed Answer Booklet. The question number(s) must be clearly shown.
- You are permitted to use a scientific or graphical calculator in this paper.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question.
- The acceleration due to gravity is denoted by $g\text{ m s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION

- The total mark for this paper is **75**.
- The marks for each question are shown in brackets [].
- **You are reminded of the need for clear presentation in your answers.**
- The Printed Answer Booklet consists of **16** pages. The Question Paper consists of **4** pages.

Answer **all** the questions.

- 1 A set of bivariate data (X, Y) is summarised as follows.

$$n = 25, \Sigma x = 9.975, \Sigma y = 11.175, \Sigma x^2 = 5.725, \Sigma y^2 = 46.200, \Sigma xy = 11.575$$

- (a) Calculate the value of Pearson's product-moment correlation coefficient. [1]
- (b) Calculate the equation of the regression line of y on x . [2]

It is desired to know whether the regression line of y on x will provide a reliable estimate of y when $x = 0.75$.

- (c) State one reason for believing that the estimate will be reliable. [1]
- (d) State what further information is needed in order to determine whether the estimate is reliable. [1]

- 2 The average numbers of cars, lorries and buses passing a point on a busy road in a period of 30 minutes are 400, 80 and 17 respectively.

- (a) Assuming that the numbers of each type of vehicle passing the point in a period of 30 minutes have independent Poisson distributions, calculate the probability that the total number of vehicles passing the point in a randomly chosen period of 30 minutes is at least 520. [3]
- (b) Buses are known to run in approximate accordance with a fixed timetable.

Explain why this casts doubt on the use of a Poisson distribution to model the number of buses passing the point in a fixed time interval. [1]

- 3 Six red counters and four blue counters are arranged in a straight line in a random order.

Find the probability that

- (a) no blue counter has fewer than two red counters between it and the nearest other blue counter, [3]
- (b) no two blue counters are next to one another. [3]

- 4 The greatest weight WN that can be supported by a shelving bracket of traditional design is a normally distributed random variable with mean 500 and standard deviation 80.

A sample of 40 shelving brackets of a new design are tested and it is found that the mean of the greatest weights that the brackets in the sample can support is 473.0 N.

- (a) Test at the 1% significance level whether the mean of the greatest weight that a bracket of the new design can support is less than the mean of the greatest weight that a bracket of the traditional design can support. [7]
- (b) State an assumption needed in carrying out the test in part (a). [1]
- (c) Explain whether it is necessary to use the central limit theorem in carrying out the test. [1]

- 5 Five runners, A, B, C, D and E , take part in two different races.

Spearman's rank correlation coefficient for the orders in which the runners finish is calculated and a test for positive agreement is carried out at the 5% significance level.

- (a) State suitable hypotheses for the test. [1]
- (b) Find the largest possible value of $\sum d^2$ for which the result of the test is to reject the null hypothesis. [3]
- (c) In the first race, the order in which the five runners finished was: A, B, C, D, E . In the second race, three of the runners finished in the same positions as in the first race. The result of the test is to reject the null hypothesis.

Find a possible order for the runners to finish in the second race. [3]

- 6 Yusha investigates the proportion of left-handed people living in two cities, A and B . He obtains data from random samples from the two cities. His results are shown in the table, in which L denotes "left-handed".

	L	L'
A	14	9
B	26	51

- (a) Test at the 10% significance level whether there is association between being left-handed and living in a particular city. [7]

A person is chosen at random from one of the cities A and B .
Let A denote "the person lives in city A ".

- (b) State the relationship between $P(L)$ and $P(L|A)$ according to the model implied by the null hypothesis of your test. [1]
- (c) Use the data in the table to suggest a value for $P(L|A)$ given by an improved model. [2]

- 7 The random variable D has the distribution $\text{Geo}(p)$. It is given that $\text{Var}(D) = \frac{40}{9}$.

Determine

(a) $\text{Var}(3D + 5)$, [1]

(b) $E(3D + 5)$, [6]

(c) $P(D > E(D))$. [3]

- 8 A university course was taught by two different professors. Students could choose whether to attend the lectures given by Professor Q or the lectures given by Professor R . At the end of the course all the students took the same examination.

The examination marks of a random sample of 30 students taught by Professor Q and a random sample of 24 students taught by Professor R were ranked. The sum of the ranks of the students taught by Professor Q was 726.

Test at the 5% significance level whether there is a difference in the ranks of the students taught by the two professors. [10]

- 9 The continuous random variable T has cumulative distribution function

$$F(t) = \begin{cases} 0 & t < 0, \\ 1 - e^{-0.25t} & t \geq 0. \end{cases}$$

(a) Find the cumulative distribution function of $2T$. [3]

(b) Show that, for constant k , $E(e^{kt}) = \frac{1}{1 - 4k}$.

You should state with a reason the range of values of k for which this result is valid. [7]

(c) T is the time before a certain event occurs.

Show that the probability that no event occurs between time $T = 0$ and time $T = \theta$ is the same as the probability that the value of a random variable with the distribution $\text{Po}(\lambda)$ is 0, for a certain value of λ . You should state this value of λ in terms of θ . [4]

END OF QUESTION PAPER

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POST-EXAM CORRECTION

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If you wish to use the published question paper as practice material, please make the following correction:

Turn to **page 4** of the **question paper** and look at question **9(b)**

Replace $E(e^{kt})$ with $E(e^{kT})$.

The question should now read:

Show that, for constant k , $E(e^{kT}) = \frac{1}{1-4k}$.

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