

**Friday 19 May 2023 – Afternoon**

**AS Level Further Mathematics A**

**Y532/01 Statistics**

**Time allowed: 1 hour 15 minutes**



**You must have:**

- the Printed Answer Booklet
- the Formulae Booklet for AS Level Further Mathematics A
- a scientific or graphical calculator



**INSTRUCTIONS**

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided in the **Printed Answer Booklet**. If you need extra space use the lined pages at the end of the Printed Answer Booklet. The question numbers must be clearly shown.
- Fill in the boxes on the front of the Printed Answer Booklet.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- 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  $g \text{ m s}^{-2}$ . When a numerical value is needed use  $g = 9.8$  unless a different value is specified in the question.
- Do **not** send this Question Paper for marking. Keep it in the centre or recycle it.

**INFORMATION**

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [ ].
- This document has **8** pages.

**ADVICE**

- Read each question carefully before you start your answer.

- 1 A radar device is used to detect flaws in motorway roads before they become dangerous. The number of flaws in a 1 km stretch of motorway is denoted by  $X$ . It may be assumed that flaws occur randomly.
- (a) State **two** further assumptions that are necessary for  $X$  to be well modelled by a Poisson distribution. [2]
- Assume now that  $X$  can be modelled by the distribution  $Po(5.7)$ .
- (b) Determine the probability that in a randomly chosen stretch of motorway, of length 1 km, there are between 8 and 11 flaws, inclusive. [2]
- (c) Determine the probability that in two randomly chosen, non-overlapping, stretches of motorway, each of length 5 km, there are at least 30 flaws in one stretch and fewer than 30 flaws in the other stretch. [3]
- 2 A music lover has 30 CDs arranged in a random order in a line on a shelf. Of these CDs, 7 are classed as Baroque, 10 as Classical and 13 as Romantic.
- (a) Determine the probability that all 7 Baroque CDs are next to each other. [3]
- (b) Determine the probability that, of the 10 CDs furthest to the left on the shelf, at least 6 are Baroque. [4]
- 3 An insurance company collected data concerning the age,  $x$  years, of policy holders and the average size of claim,  $\pounds y$  thousand. The data is summarised as follows.
- $$n = 32 \quad \sum x = 1340 \quad \sum y = 612 \quad \sum x^2 = 64\,282 \quad \sum y^2 = 13\,418 \quad \sum xy = 27\,794$$
- (a) Find the variance of  $x$ . [1]
- (b) Find the equation of the regression line of  $y$  on  $x$ . [2]
- (c) Hence estimate the expected size of claim from a policy holder of age 48. [1]
- Tom is aged 48. He claims that the range of the data probably does not include people of his age because the mean age for the data is 41.875, and 48 is not close to this.
- (d) Use your answer to part (a) to determine how likely it is that Tom's claim is correct. [2]
- (e) Comment on the reliability of your estimate in part (c). You should refer to the value of the product-moment correlation coefficient for the data, which is 0.579 correct to 3 significant figures. [2]

- 4 A discrete random variable  $W$  has the probability distribution shown in the following table, in which  $a$  and  $b$  are constants.

$w$	58	59	60	61	62	63
$P(W = w)$	$a$	$b$	0.2	0.2	0.1	0.1

It is given that  $E(W - 60) = 0.15$ .

Determine the value of  $\text{Var}(4W - 60)$ .

[7]

- 5 A psychologist investigates the relationship between ‘openness’ and ‘creativity’ in adults. Each member of a random sample of 15 adults is given two tests, one on openness and one on creativity. Each test has a maximum score of 75. The results are given in the table.

Adult	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Openness, $x$	39	34	29	20	40	35	20	36	55	31	41	43	33	30	33
Creativity, $y$	59	34	17	29	49	46	45	54	60	38	46	35	43	56	34

$$n = 15 \quad \sum x = 519 \quad \sum y = 645 \quad \sum x^2 = 19\,033 \quad \sum y^2 = 29\,751 \quad \sum xy = 23\,034$$

- (a) Use Pearson’s product-moment correlation coefficient to test, at the 5% significance level, whether there is positive association between openness and creativity. [6]
- (b) State what the value of Pearson’s product-moment correlation coefficient shows about a scatter diagram illustrating the data. [2]
- (c) A student suggests that there is a way to obtain a more accurate measure of the correlation. Before carrying out the test it would be better to standardise the test scores so that they have the same mean and variance.

Explain whether you agree with this suggestion.

[1]

- 6 A machine is used to toss a coin repeatedly. Rosa believes that the outcome of each toss made by the machine is not independent of the previous toss. Rosa gets the machine to toss a coin 6 times and record the number of heads,  $X$ , obtained. After recording the number of heads obtained, Rosa resets the machine and gets it to toss the coin 6 more times. Rosa again records the number of heads obtained and she repeats this procedure until she has recorded 88 independent values of  $X$ .

- (a) The sample mean and sample variance of  $X$  are 3.35 and 3.392 respectively.

Explain what these results suggest about the validity of a binomial model  $B(6, p)$  for the data. [3]

Rosa uses a computer spreadsheet to work out the probabilities for a more sophisticated model in which the outcome of each toss is dependent on the outcome of the previous toss. Her model suggests that the probabilities  $P(X = x)$ , for  $x = 0, 1, 2, 3, 4, 5, 6$ , are approximately in the ratio  $5 : 6 : 7 : 8 : 7 : 6 : 5$ . She carries out a  $\chi^2$  test to investigate whether this model is a good fit for the data.

The following table shows the full results of the experiments, together with some of the calculations needed for the test.

$x$	0	1	2	3	4	5	6	Total
Observed frequency	7	10	16	15	15	11	14	88
Expected frequency								
Contribution to $\chi^2$ statistic	0.9	0.3333	0.2857	0.0625	0.0714			

- (b) In the Printed Answer Booklet, complete the table. [3]
- (c) Carry out the test, using a 10% significance level. [4]
- (d) Rosa says that the results definitely show that one of the two proposed models is correct. Comment on this statement. [2]

- 7 A town council is planning to introduce a new set of parking regulations. An interviewer contacts randomly chosen people in the town and asks them whether they are in favour of the proposal. The first person who is not in favour of the regulation is the  $R$ th person interviewed. It can be assumed that the probability that any randomly chosen person is not in favour of the proposal is a constant  $p$ , and that  $p$  does not equal 0 or 1.

Assume first that  $E(R) = 10$ .

- (a) Determine  $P(R \geq 14)$ . [3]

Now, without the assumption that  $E(R) = 10$ , consider a general value of  $p$ .

It is given that  $P(R = 3) - 0.4 \times P(R = 2) - a \times P(R = 1) = 0$ , where  $a$  is a positive constant.

- (b) Determine the range of possible values of  $a$ . [7]

**END OF QUESTION PAPER**

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