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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Sample Assessment Material

(Time: 1 hour 30 minutes) | Paper Reference **9FM0/4B**

Further Mathematics
Advanced
Paper 4B: Further Statistics 2

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions
- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information
- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice
- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL questions. Write your answers in the spaces provided.

1. A magazine editor believes that shorter articles are more likely to be read than longer ones. She asked a large random sample of subscribers which of 10 articles from the magazine they had read. She then ranked the articles from 1 to 10 with 1 being the article read the most.

The editor then counted the number of words in each of the 10 articles and her results are given in the table.

Article	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Read rank	4	6	1	10	8	2	7	5	3	9
No. of words	567	2613	350	2580	1214	485	785	819	620	726

(a) Calculate Spearman's rank correlation coefficient for these data.

(4)

(b) Test the editor's belief. Use a 5% significance level and state your hypotheses clearly.

(3)

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Question 1 continued

(Total for Question 1 is 7 marks)

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2. New recruits to *Sonarep* are given a two-part test covering spatial and numerical skills. The scores on each part of the test are normally distributed.
The recruitment manager believes that the mean score for spatial skills is more than the mean score for numerical skills and wishes to find a 95% confidence interval for the mean difference. She took a random sample of 8 recruits and recorded their scores on each part of the test. The results are given in the table.

Recruit	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Spatial skills	41	38	29	45	37	48	33	36
Numerical skills	35	32	31	37	38	36	33	26

(a) Calculate a 95% confidence interval for the difference in mean scores between the two parts of the test.

(5)

(b) State, giving a reason, whether or not the confidence interval supports the recruitment manager's belief.

(2)

The deputy manager treated these data as two independent samples and obtained a 95% confidence interval for the difference in mean scores of (−0.67, 10.42)

(c) Explain why this treatment of these data is not correct.

(1)

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Question 2 continued

(Total for Question 2 is 8 marks)

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3. George took a random sample of 8 apples from the tree in his garden. The weight, x grams, of each apple was recorded. The results are summarised by

$$\sum x = 752 \text{ and } \sum x^2 = 73\,094$$

(a) Calculate a 90% confidence interval for the standard deviation, σ, of the weights of apples from the tree in George's garden.

(6)

(b) State an assumption about the weights of apples from the tree that is needed to carry out the calculation in part (a).

(1)

(c) State, giving a reason, whether or not the confidence interval in part (a) supports the assertion that $\sigma = 26$ grams.

(2)

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Question 3 continued

(Total for Question 3 is 9 marks)

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4. As part of a winter sports day both boys and girls complete a cross country course. The times taken, in minutes, by a random sample of 9 girls are given below.

35.6 28.7 23.4 42.1 38.9 31.6 34.7 26.3 37.2

(a) Find unbiased estimates of the mean and variance of the times taken by the girls to complete the course.

(2)

The times, x minutes, taken by a random sample of 6 boys to complete the course are summarised by the following statistics

$$\bar{x} = 27.45 \qquad s_x^2 = 15.77$$

(b) Test, at the 10% level of significance, whether or not there is a difference in the variances of the times taken by the girls and the times taken by the boys to complete the course. State your hypotheses clearly.

(4)

A sports teacher at the school believes that the mean time taken by the girls to complete the course is more than 2 minutes longer than the mean time taken by the boys.

(c) Stating your hypotheses clearly, test the teacher's belief at the 5% level of significance.

(6)

(d) State an assumption about the distribution of the times taken to complete the course for the tests in part (b) and part (c) to be valid.

(1)

(e) Explain the relevance of the test in part (b) to the test in part (c).

(1)

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Question 4 continued

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Question 4 continued

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Question 4 continued

(Total for Question 4 is 14 marks)

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5. *Eusain Engineering* manufactures bolts in large batches. The lengths of the bolts, in mm, follow a normal distribution with mean 38 mm and standard deviation 0.3 mm.

A random sample of 3 bolts is taken and the lengths measured.

Find the probability that the difference between the mean length of the first 2 bolts and the mean length of all 3 bolts is greater than 0.2 mm.

(7)

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Question 5 continued

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Question 5 continued

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Question 5 continued

(Total for Question 5 is 7 marks)

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6. The continuous random variable X has probability density function

$$f(x) = \begin{cases} \frac{1}{2\pi}(1 - \cos x) & 0 \leqslant x \leqslant 2\pi \\ 0 & \text{otherwise} \end{cases}$$

(a) Sketch $f(x)$.

(2)

(b) Use algebraic integration to show that $E(X^2) = \frac{4\pi^2}{3} - 2$

(4)

(c) Hence find the standard deviation of X.

(2)

The lower quartile of X is 2.31 (correct to 3 significant figures).
Jeff suggests using the normal distribution, with the same mean and standard deviation as X, to estimate the interquartile range of X.

(d) Find the percentage error of this estimate.

(4)

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Question 6 continued

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Question 6 continued

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Question 6 continued

(Total for Question 6 is 12 marks)

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7. A local chamber of commerce researcher collected information from a random sample of 8 new retail companies. The number of employees, m, and the company turnover in £10 000, t, was recorded for each company.
The results are summarised below

$$\bar{m} = 8 \qquad \bar{t} = 62 \qquad S_{mm} = 246 \qquad S_{tt} = 20\,461.16 \qquad S_{mt} = 2076.8$$

(a) Calculate the product moment correlation coefficient for these data.

(2)

(b) Stating your hypotheses clearly, test at the 5% level of significance whether or not there is a positive correlation between number of employees and company turnover.

(3)

Steve owns a small retail company and is thinking of increasing the number of people he employs. He believes that there may be a relationship between number of employees and company turnover and he wants to use this to estimate the change in turnover.

(c) (i) State, giving a reason, the form of a suitable relationship Steve can use that is consistent with your answer to part (b).

(1)

(ii) Find the equation of this model.

(3)

(d) Use this model to estimate the change in turnover, in £, if Steve increases the number of employees from 13 to 16

(2)

Question 7 continues on page 22

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Question 7 continued

Question 7 continues on page 22

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Question 7 continued

The residuals for the model Steve used are given in the table below.

Number of employees	1	2	4	6	9	10	14	18
Residual	26.6	13.5	−8.8	−14.5	−21.9	−26.4	9.8	21.9

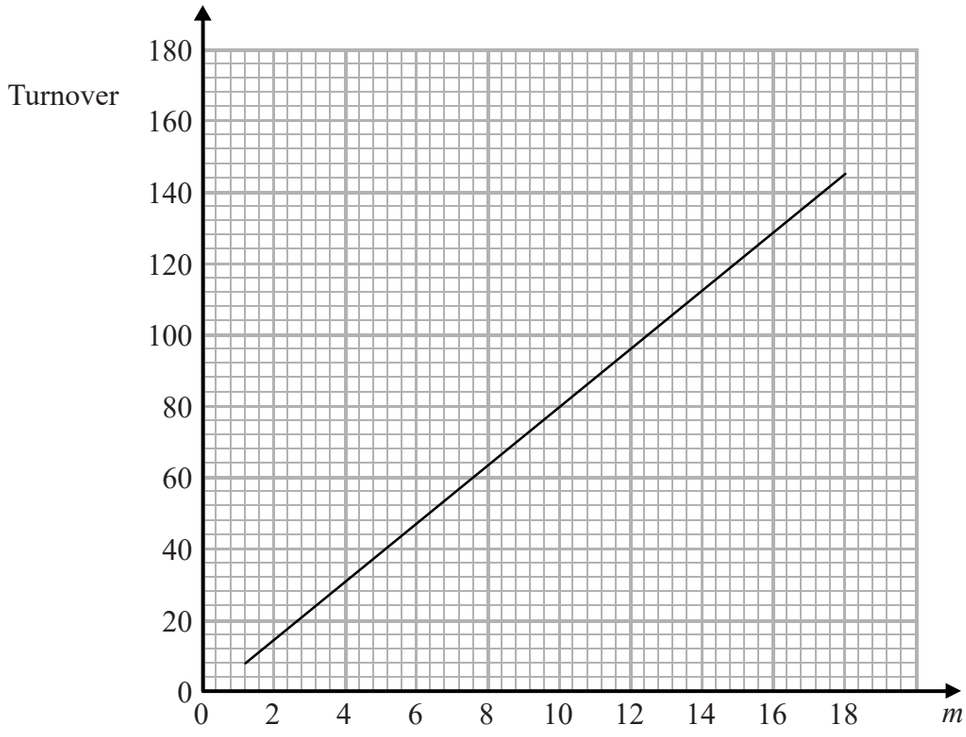

Figure 1

Figure 1 shows a sketch of Steve's model.

(e) On Figure 1 sketch the scatter diagram for Steve's data.

(2)

(f) Use your scatter diagram and the table of residuals to refine the model and calculate a revised estimate for your answer to part (d). Explain clearly how you calculated your estimate.

(2)

Given that there are 4 positive and 4 negative residuals,

(g) find the probability that a random pattern of residuals is $+ + - - - - + +$

(2)

With reference to your answers to part (a) and part (g),

(h) suggest what Steve should do to investigate further.

(1)

Turn to page 24 for a spare grid if you need to redraw your scatter diagram.

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Question 7 continued

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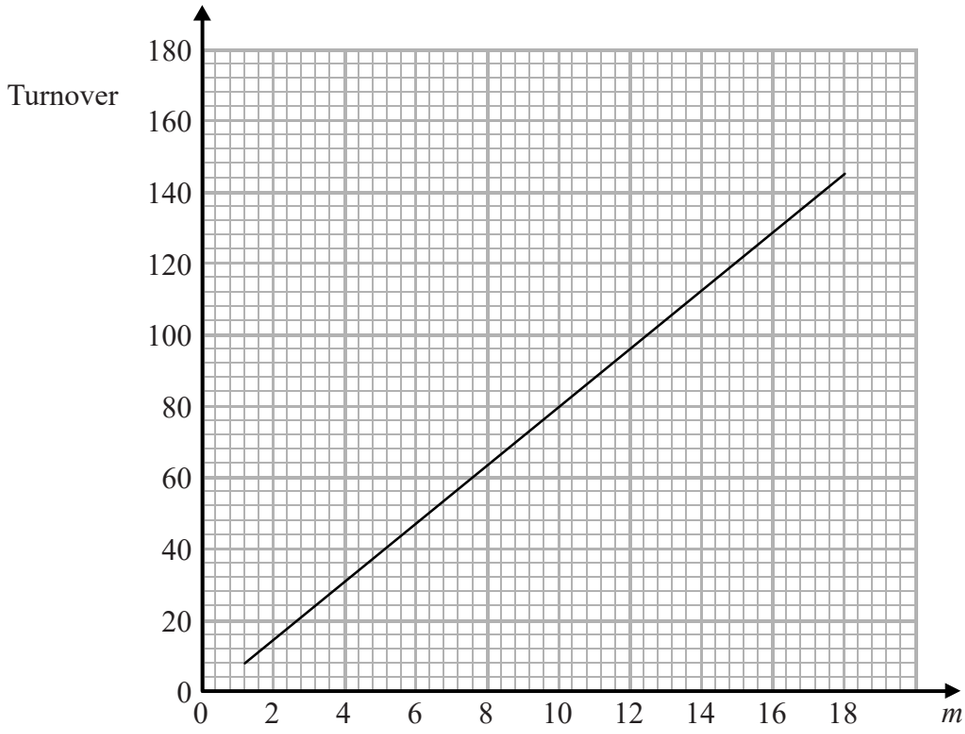
Question 7 continued

Only use this grid if you need to redraw your scatter diagram.



(Total for Question 7 is 18 marks)

TOTAL FOR PAPER IS 75 MARKS

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