

Please check the examination details below before entering your candidate information

Candidate surname

Other names

**Pearson Edexcel  
Level 3 GCE**

Centre Number

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Candidate Number

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**Tuesday 23 June 2020**

Afternoon (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 (Green), 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.
- Values from statistical tables should be quoted in full. If a calculator is used instead of the tables the value should be given to an equivalent degree of accuracy.
- Inexact answers should be given to three significant figures unless otherwise stated.

### Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 8 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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- 1 Gina receives a large number of packages from two companies,  $A$  and  $B$ . She believes that the variance of the weights of packages from company  $A$  is greater than the variance of the weights of packages from company  $B$ .

Gina takes a random sample of 7 packages from company  $A$  and an independent random sample of 10 packages from company  $B$ . Her results are summarised below

$$\bar{a} = 300 \quad S_{aa} = 145496 \quad \bar{b} = 233.4 \quad S_{bb} = 56364.4$$

[You may assume that the weights of packages from the two companies are normally distributed.]

Test Gina's belief. Use a 5% level of significance and state your hypotheses clearly.

(6)

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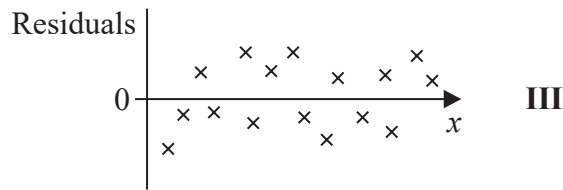
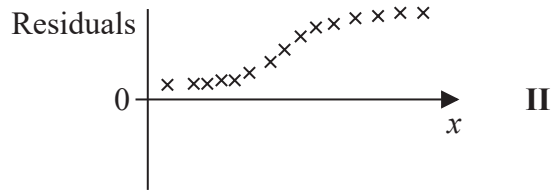
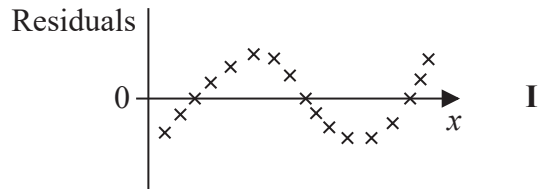
**Question 2 continued**

Lined writing area for the response to Question 2.

**(Total for Question 2 is 6 marks)**



- 3 Below are 3 sketches from some students of the residuals from their linear regressions of  $y$  on  $x$ .



For each sketch you should state, giving your reason,

- (i) whether or not the sketch is feasible

and if it is feasible

- (ii) whether or not the sketch suggests a linear or a non-linear relationship between  $y$  and  $x$ .

(6)

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- 4 A biased coin has a probability  $p$  of landing on heads, where  $0 < p < 1$ . Simon spins the coin  $n$  times and the random variable  $X$  represents the number of heads. Taruni spins the coin  $m$  times,  $m \neq n$ , and the random variable  $Y$  represents the number of heads.

Simon and Taruni want to combine their results to find unbiased estimators of  $p$ .

Simon proposes the estimator  $S = \frac{X + Y}{m + n}$  and Taruni proposes  $T = \frac{1}{2} \left[ \frac{X}{n} + \frac{Y}{m} \right]$

- (a) Show that both  $S$  and  $T$  are unbiased estimators of  $p$ . (3)

- (b) Prove that, for all values of  $m$  and  $n$ ,  $S$  is the better estimator. (4)







**Question 4 continued**

Lined writing area for the response to Question 4.

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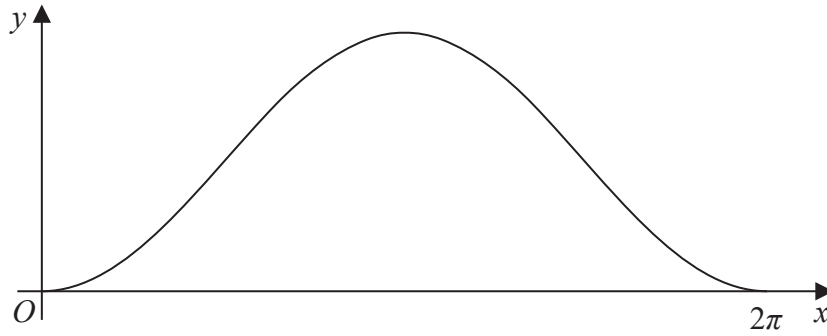


Figure 1

The random variable  $X$  has probability density function  $f(x)$  and Figure 1 shows a sketch of  $f(x)$  where

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

(a) Show that  $k = \frac{1}{2\pi}$

(3)

The random variable  $Y \sim N(\mu, \sigma^2)$  and  $E(Y) = E(X)$

The probability density function of  $Y$  is  $g(y)$ , where

$$g(y) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2} \quad -\infty < y < \infty$$

Given that  $g(\mu) = f(\mu)$

(b) find the exact value of  $\sigma$

(3)

(c) Calculate the error in using  $P\left(\frac{\pi}{2} < Y < \frac{3\pi}{2}\right)$  as an approximation to  $P\left(\frac{\pi}{2} < X < \frac{3\pi}{2}\right)$

(4)



**Question 5 continued**

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Handwriting practice area with 30 horizontal lines.



Question 5 continued

Ruled area for writing the answer to Question 5, consisting of multiple horizontal lines.

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6 A new employee, Kim, joins an existing employee, Jiang, to work in the quality control department of a company producing steel rods.

Each day a random sample of rods is taken, their lengths measured and a 95% confidence interval for the mean length of the rods, in metres, is calculated. It is assumed that the lengths of the rods produced are normally distributed.

Kim took a random sample of 25 rods and used the  $t$  distribution to obtain a 95% confidence interval of (1.193, 1.367) for the mean length of the rods.

Jiang commented that this interval was a little wider than usual and explained that they usually assume that the standard deviation does not change and can be taken as 0.175 metres.

(a) Test, at the 10% level of significance, whether or not Kim's sample suggests that the standard deviation is different from 0.175 metres. State your hypotheses clearly.

(9)

Using Kim's sample and the normal distribution with a standard deviation of 0.175 metres,

(b) find a 95% confidence interval for the mean length of the rods.

(3)



















