OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL A LEVEL
FURTHER MATHEMATICS

Further Statistics 2

Specimen paper 0X:00 GMT Time allowed: 1 hour 15 minutes

Materials
- For this paper you must have the OxfordAQA Pure Mathematics and Statistics Examination Booklet (enclosed)
- You may use a graphical calculator.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to **three** significant figures, unless stated otherwise.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise, marks may not be awarded.

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Answer **all** questions in the spaces provided.

1 The thickness X mm of steel plates produced at a factory follows a normal distribution with a standard deviation of 0.8 mm.

An engineer constructs a 92% confidence interval for the population mean thickness of the plates.

The width of this confidence interval is 0.25 mm.
A random sample of n plates is taken.

1 (a) Find the value of n

[3 marks]

$n =$ _____

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1 (b) The total thickness of the plates in the sample is 1260 mm.

Find the engineer's 92% confidence interval for the population mean thickness.

Give your values to three decimal places.

[3 marks]

Answer _____

Turn over for the next question

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2 A medical centre is testing two different models of pumps: model A and model B

The medical centre will use the model that has the smaller population variance in the volume of liquid produced.

Random samples of volumes v microlitres produced by each model are taken.

Assume that the populations of volumes produced for both models are normally distributed and independent.

The summary results of the samples are shown in **Figure 1**

Figure 1

Model	Sample Size	$\sum(v-\overline{v})^2$
A	9	128.4
B	13	312.6

Test at the 10% level of significance whether there is evidence for the medical centre to prefer one model instead of the other.

[8 marks]

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Turn over for the next question

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3 A continuous random variable W represents the mass in grams of a bag of sugar.

The moment generating function of W is given by

$$\mathrm{M}_W(t) = \mathrm{e}^{505t+18t^2}$$

3 (a) (i) Use $\mathrm{M}_W(t)$ to show that $\mathrm{E}(W) = 505$

[2 marks]

3 (a) (ii) Use $\mathrm{M}_W(t)$ to show that $\mathrm{Var}(W) = 36$

[3 marks]

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3 (b) The random variable X is given by

$$X = aW + b$$

where a and b are constants.

3 (b) (i) Determine the moment generating function $\mathrm{M}_X(t)$

Give your answer in the form $\mathrm{e}^{\mathrm{f}(t)}$ where f is a function of t

[2 marks]

Answer _____

3 (b) (ii) State $\mathrm{E}(X)$ and $\mathrm{Var}(X)$ in terms of a and b

[1 mark]

$\mathrm{E}(X) =$ _____ $\mathrm{Var}(X) =$ _____

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4 A hamster is a small animal.

Scott is investigating the mass in grams of a type of hamster.

The masses of this type of hamster follow a normal distribution.

Scott claims that the population standard deviation for the mass of this type of hamster is 12 grams.

He takes a random sample of 51 hamsters.

The standard deviation of this sample is 14.2 grams.

4 (a) Test Scott's claim using the 10% level of significance.

[6 marks]

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4 (b) A guinea pig is also a small animal.

Scott is also investigating the mass of a type of guinea pig.

The masses of this type of guinea pig follow a normal distribution.

He takes a random sample of 41 guinea pigs.

The standard deviation of this sample is 16.5 grams.

Scott makes a second claim that the population variance for the mass of the guinea pigs is greater than the population variance for the mass of the hamsters.

Assume that the masses of the hamsters and the masses of guinea pigs are independent.

Test Scott's second claim at the 5% level of significance.

[6 marks]

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5 The number of surface faults on a new car panel follows a Poisson distribution with mean λ

A technician performs a hypothesis test at the 10% level of significance with the hypotheses

$$H_0 : \lambda = 5$$
$$H_1 : \lambda \neq 5$$

It is given that the actual value of λ is 7

5 (a) Find the probability that the technician makes a Type II error.

Give your answer to three decimal places.

[6 marks]

Answer _____

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5 (b) Find the power of the technician's hypothesis test.

[1 mark]

Answer _____

Turn over for the next question

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6 Two independent random samples of size n and m

$$X_1, X_2, X_3, ..., X_n \quad \text{and} \quad Y_1, Y_2, Y_3, ..., Y_m$$

are taken from the same population with mean μ and variance σ^2

The estimator W is given by

$$W = \frac{n\overline{X} + m\overline{Y}}{n+m}$$

where

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \quad \text{and} \quad \overline{Y} = \frac{1}{m}\sum_{i=1}^{m} Y_i$$

6 (a) Determine whether W is an unbiased estimator of μ

Fully justify your answer.

[3 marks]

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6 (b) Show that the variance of W is $\frac{\sigma^2}{n+m}$

[2 marks]

6 (c) Determine whether W is a consistent estimator of μ

Fully justify your answer.

[2 marks]

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7 A researcher is investigating the number of rare birds X spotted in each of 200 forest sectors in a nature reserve over a weekend.

The observed frequencies are shown in **Figure 2**

Figure 2

Number of rare birds spotted	0	1	2	3	4	5	≥ 6
Observed frequency	18	52	65	41	19	5	0

The researcher claims that the number of rare birds X spotted in each of 200 forest sectors in a nature reserve over a weekend can be modelled by $X \sim \mathrm{B}(5, p)$

7 (a) (i) Explain why the researcher should choose $p = 0.4$ correct to one decimal place.

[2 marks]

7 (a) (ii) **Figure 3** shows four expected frequencies calculated using $X \sim \mathrm{B}(5, 0.4)$, correct to two decimal places.

Complete the table in **Figure 3**

Give your values to two decimal places.

[2 marks]

Figure 3

Number of rare birds spotted	0	1	2	3	4	5
Expected frequency	15.55	51.84	69.12			2.05

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7 (b) Test the researcher's claim using the 5% level of significance.

[8 marks]

END OF QUESTIONS

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