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Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

## Friday 12 January 2024

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WST02/01**

# Mathematics

## International Advanced Subsidiary/Advanced Level
## Statistics S2

**You must have:**
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

**Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra 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 the 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 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

*Turn over* ▶

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**1.** The manager of a supermarket is investigating the number of complaints per day received from customers.

A random sample of 180 days is taken and the results are shown in the table below.

| **Number of complaints per day** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | $\geqslant 7$ |
|---|---|---|---|---|---|---|---|---|
| **Frequency** | 12 | 28 | 37 | 38 | 29 | 17 | 19 | 0 |

(a) Calculate the mean and the variance of these data.

**(3)**

(b) Explain why the results in part (a) suggest that a Poisson distribution may be a suitable model for the number of complaints per day.

**(1)**

The manager uses a Poisson distribution with mean 3 to model the number of complaints per day.

(c) For a randomly selected day find, using the manager's model, the probability that there are

(i) at least 3 complaints,

(ii) more than 4 complaints but less than 8 complaints.

**(4)**

A week consists of 7 consecutive days.

(d) Using the manager's model and a suitable approximation, show that the probability that there are less than 19 complaints in a randomly selected week is 0.29 to 2 decimal places.
Show your working clearly.
(*Solutions relying on calculator technology are not acceptable.*)

**(5)**

A period of 13 weeks is selected at random.

(e) Find the probability that in this period there are exactly 5 weeks that have less than 19 complaints.
Show your working clearly.

**(3)**

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**Question 1 continued**

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**Question 1 continued**

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**Question 1 continued**

**(Total for Question 1 is 16 marks)**

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**2.** The length of pregnancy for a randomly selected pregnant sheep is $D$ days where

$$D \sim \mathrm{N}(112.4, \sigma^2)$$

Given that 5% of pregnant sheep have a length of pregnancy of less than 108 days,

(a) find the value of $\sigma$

**(3)**

Qiang selects 25 pregnant sheep at random from a large flock.

(b) Find the probability that more than 3 of these pregnant sheep have a length of pregnancy of less than 108 days.

**(2)**

Charlie takes 200 random samples of 25 pregnant sheep.

(c) Use a Poisson approximation to estimate the probability that at least 2 of the samples have more than 3 pregnant sheep with a length of pregnancy of less than 108 days.

**(3)**

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**Question 2 continued**

**(Total for Question 2 is 8 marks)**

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**3.** Rowan believes that 35% of type *A* vacuum tubes shatter when exposed to alternating high and low temperatures.

Rowan takes a random sample of 15 of these type *A* vacuum tubes and uses a two-tailed test, at the 5% level of significance, to test his belief.

(a) Give **two** assumptions, in context, that Rowan needs to make for a binomial distribution to be a suitable model for the number of these type *A* vacuum tubes that shatter when exposed to alternating high and low temperatures.

**(2)**

(b) Using a binomial distribution, find the critical region for the test.
You should state the probability of rejection in each tail, which should be as close as possible to 0.025

**(3)**

(c) Find the actual level of significance of the test based on your critical region from part (b)

**(1)**

Rowan records that in the latest batch of 15 type *A* vacuum tubes exposed to alternating high and low temperatures, 4 of them shattered.

(d) With reference to part (b), comment on Rowan's belief. Give a reason for your answer.

**(1)**

Rowan changes to type *B* vacuum tubes. He takes a random sample of 40 type *B* vacuum tubes and finds that 8 of them shatter when exposed to alternating high and low temperatures.

(e) Test, at the 5% level of significance, whether or not there is evidence that the proportion of type *B* vacuum tubes that shatter when exposed to alternating high and low temperatures is lower than 35%
You should state your hypotheses clearly.

**(5)**

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**Question 3 continued**

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**Question 3 continued**

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**Question 3 continued**

**(Total for Question 3 is 12 marks)**

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**4.** The continuous random variable $G$ has probability density function f($g$) given by

$$\text{f}(g) = \begin{cases} \frac{1}{15}(g+3) & -1 < g \leqslant 2 \\ \frac{3}{20} & 2 < g \leqslant 4 \\ 0 & \text{otherwise} \end{cases}$$

(a) Sketch the graph of f($g$)

**(2)**

(b) Find $\text{P}\left(\left(1 \leqslant 2G \leqslant 6\right) \middle| G \leqslant 2\right)$

**(4)**

The continuous random variable $H$ is such that E($H$) = 12 and Var($H$) = 2.4

(c) Find $\text{E}\left(2H^2 + 3G + 3\right)$
Show your working clearly.
(*Solutions relying on calculator technology are not acceptable.*)

**(6)**

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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 12 marks)**

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**5.** The random variable $W$ has a continuous uniform distribution over the interval $[-6, a]$ where $a$ is a constant.

Given that $\text{Var}(W) = 27$

(a) show that $a = 12$

**(2)**

Given that $\text{P}(W > b) = \frac{3}{5}$

(b) (i) find the value of $b$

**(2)**

(ii) find $\text{P}\left(-12 < W < \frac{b}{2}\right)$

**(2)**

A piece of wood $AB$ has length 160 cm. The wood is cut at random into 2 pieces. Each of the pieces is then cut in half. The four pieces are used to form the sides of a rectangle.

(c) Calculate the probability that the area of the rectangle is greater than $975\,\text{cm}^2$

**(4)**

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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 10 marks)**

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**6.** A bag contains a large number of counters with an odd number or an even number written on each.

Odd and even numbered counters occur in the ratio 4 : 1

In a game a player takes a random sample of 4 counters from the bag.

The player scores

5 points for each counter taken that has an even number written on it

2 points for each counter taken that has an odd number written on it

The random variable $X$ represents the total score, in points, from the 4 counters.

(a) Find the sampling distribution of $X$

**(6)**

A random sample of $n$ sets of 4 counters is taken. The random variable $Y$ represents the number of these $n$ sets that have a total score of exactly 14

(b) Calculate the minimum value of $n$ such that $P(Y \geqslant 1) > 0.95$

**(3)**

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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 9 marks)**

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**7.** A continuous random variable $X$ has cumulative distribution function $F(x)$ given by

$$F(x) = \begin{cases} 0 & x < 1 \\ k(ax + bx^3 - x^4 - 4) & 1 \leqslant x \leqslant 2 \\ 1 & x > 2 \end{cases}$$

where $a$, $b$ and $k$ are non-zero constants.

Given that the mode of $X$ is 1.5

(a) show that $b = 3$

**(3)**

(b) Hence show that $a = 2$

**(1)**

(c) Show that the median of $X$ lies between 1.4 and 1.5

**(4)**

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**Question 7 continued**

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**Question 7 continued**

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**Question 7 continued**

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**(Total for Question 7 is 8 marks)**

**TOTAL FOR PAPER IS 75 MARKS**