Please check the examination details below before entering your candidate information

Candidate surname StemUp Model Solution | Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Friday 31 October 2025

Morning (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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Pearson

1. The captain of a large sports club wants to survey a random sample of the club's members to obtain their opinions about proposed changes to the clubhouse.

(a) Suggest a suitable sampling frame for the survey.

(1)

(b) Identify the sampling units for the survey.

(1)

(c) Give one advantage **and** one disadvantage of taking a random sample rather than a census.

(2)

(a) A list (register) of all the members of the sports club

(b) The individual members of the sports club

(c) Advantage: a random sample is quicker and cheaper to carry out and the results are easier to analyse.

Disadvantage: the sample may not be representative of the whole population (of club members).

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Question 1 continued

(Total for Question 1 is 4 marks)

2. The manager of a supermarket records the number of complaints, x, the supermarket receives each day over a 50-day period. The results are summarised below.

$$\sum x = 99 \text{ and } \sum (x - \bar{x})^2 = 97.5$$

The manager believes that the number of complaints received by the supermarket each day could be modelled by a Poisson distribution.

(a) Show how the results above support the manager in his belief.

(3)

The manager uses a Poisson distribution with mean 2 to model the number of complaints received each day.

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

(i) at least 4 complaints received,

(ii) more than 2 but less than 7 complaints received.

(4)

A working week consists of 5 consecutive days.

In a randomly selected working week, the supermarket received 17 complaints.

(c) Test, at the 5% level of significance, whether there is significant evidence that the mean number of complaints received is greater than 2 per day.
State your hypotheses clearly.

(5)

(a) Mean $= \frac{99}{50} = 1.98$

Variance $= \frac{97.5}{50} = 1.95$

Mean ≈ variance (1.98 ≈ 1.95), which is a property of a Poisson distribution, so the results support the manager's belief.

(b) $X \sim Po(2)$

(i) $P(X \geqslant 4) = 1 - P(X \leqslant 3) = 1 - 0.8571$
$= 0.1429$ (calc 0.1428765...)

(ii) $P(2 < X < 7) = P(X \leqslant 6) - P(X \leqslant 2) = 0.9955 - 0.6767$
$= 0.3188$ (calc 0.318789...)

(c) Let λ = mean number of complaints in a 5-day working week

H_0: $\lambda = 10$ H_1: $\lambda > 10$

Under H_0, $Y \sim Po(10)$ (Y = number of complaints in 5 days)

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Question 2 continued

$P(Y \geqslant 17) = 1 - P(Y \leqslant 16) = 1 - 0.9730$

$= 0.0270 \quad < 0.05$

Significant, so reject H_0 (17 is in the critical region $Y \geqslant 16$)

There is sufficient evidence to suggest that the mean number of complaints received is greater than 2 per day.

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Question 2 continued

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Question 2 continued

(Total for Question 2 is 12 marks)

3. (a) Explain what you understand by the sampling distribution of a statistic.

(1)

A bag contains a large number of £1 coins and a large number of £2 coins only.

A random sample of 3 coins is taken from the bag.

(b) List all the possible combinations of the 3 coins that might be selected.

(2)

The probability of selecting a £1 coin from the bag is p and the probability of selecting a £2 coin from the bag is q

Let $\bar{X}$ represent the mean value of the 3 coins selected.

The sampling distribution of $\bar{X}$ is given below

$\bar{x}$	1	$\frac{4}{3}$	a	2
$P(\bar{X} = \bar{x})$	$\frac{27}{125}$	b	c	d

where a, b, c and d are constants.

(c) State the value of a

(1)

(d) Find the value of b, the value of c and the value of d

(6)

Let M represent the modal value of the 3 coins selected.

(e) Find the sampling distribution of M

(3)

(a) *The probability distribution of a statistic: all the possible values of the statistic (from all possible samples) together with their associated probabilities.*

(b) {£1, £1, £1}, {£1, £1, £2}, {£1, £2, £2}, {£2, £2, £2}

(c) $a = \frac{5}{3}$

(d) $P(\bar{X} = 1) = P(£1, £1, £1) = p^3 = \frac{27}{125}$

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Question 3 continued

$p = \frac{3}{5} = 0.6 \qquad q = 1 - 0.6 = 0.4$

$b = P\left(\bar{X} = \frac{4}{3}\right) = 3p^2q = 3 \times 0.6^2 \times 0.4 = \frac{54}{125} = 0.432$

$c = P\left(\bar{X} = \frac{5}{3}\right) = 3pq^2 = 3 \times 0.6 \times 0.4^2 = \frac{36}{125} = 0.288$

$d = P(\bar{X} = 2) = q^3 = 0.4^3 = \frac{8}{125} = 0.064$

(e) $M = 1$ for $\{1, 1, 1\}$ or $\{1, 1, 2\}$; $M = 2$ for $\{1, 2, 2\}$ or $\{2, 2, 2\}$

$P(M = 1) = \frac{27}{125} + \frac{54}{125} = \frac{81}{125} \qquad P(M = 2) = \frac{36}{125} + \frac{8}{125} = \frac{44}{125}$

m	1	2
$P(M = m)$	$\frac{81}{125}$	$\frac{44}{125}$

Question 3 continued

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Question 3 continued

(Total for Question 3 is 13 marks)

4. The continuous random variable X has cumulative distribution function $F(x)$ given by

$$F(x) = \begin{cases} 0 & x < 1 \\ \frac{1}{24}(x-1)^2 & 1 \leqslant x \leqslant 3 \\ \frac{1}{6}(x-2) & 3 < x \leqslant 6 \\ -k\left(x^2 - 20x + 52\right) & 6 < x \leqslant 10 \\ 1 & x > 10 \end{cases}$$

where k is a positive constant.

(a) Show that $k = \frac{1}{48}$

(2)

(b) Write down the value of $P(X = 4)$

(1)

(c) Find the value of

$$P(2.5 < X < 4.5) + P(5.5 < X < 8.5)$$

(3)

The probability density function of X is given by

$$f(x) = \begin{cases} r(x) & 1 \leqslant x \leqslant 3 \\ \frac{1}{6} & 3 < x \leqslant 6 \\ s(x) & 6 < x \leqslant 10 \\ 0 & \text{otherwise} \end{cases}$$

(d) Find $r(x)$ and $s(x)$

(3)

(a) $F(10) = 1 \Rightarrow -k(10^2 - 20 \times 10 + 52) = 1$

$-k(100 - 200 + 52) = 1 \Rightarrow 48k = 1$

$k = \frac{1}{48}$ as required

(b) $P(X = 4) = 0$

(c) $= F(4.5) - F(2.5) + F(8.5) - F(5.5)$

$= \frac{1}{6}(4.5 - 2) - \frac{1}{24}(2.5 - 1)^2 - \frac{1}{48}(8.5^2 - 20 \times 8.5 + 52) - \frac{1}{6}(5.5 - 2)$

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Question 4 continued

$= \frac{5}{12} - \frac{3}{32} + \frac{61}{64} - \frac{7}{12}$

$= \frac{133}{192}$ $(= 0.6927\ldots)$

(d) $r(x) = \frac{d}{dx}\left[\frac{1}{24}(x-1)^2\right] = \frac{2}{24}(x-1) = \frac{1}{12}x - \frac{1}{12}$

$s(x) = \frac{d}{dx}\left[-\frac{1}{48}(x^2 - 20x + 52)\right] = -\frac{1}{48}(2x - 20) = \frac{5}{12} - \frac{1}{24}x$

Question 4 continued

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Question 4 continued

(Total for Question 4 is 9 marks)

5. It is known that a particular variety of tulip produces yellow flowers with a probability of 0.25

A random sample of 15 tulips of this variety is purchased.

(a) Find the probability that more than 4 of these tulips will produce yellow flowers.

(2)

(b) Find the least number of tulips that needs to be purchased so that the probability of at least 1 tulip producing yellow flowers exceeds 0.95

(3)

Another random sample of 100 tulips of this variety is purchased.

(c) Use a suitable approximation to find the probability that, of these 100 tulips, more than 21 but no more than 30 will produce yellow flowers.
Show your working clearly.

(*Solutions relying entirely on calculator technology are not acceptable.*)

(5)

For this particular variety, it is thought that the probability of a tulip producing red flowers is 0.3

A random sample of 25 tulips of this variety was purchased. When these tulips flowered, 10 of them produced red flowers.

(d) Use this random sample of 25 tulips to test whether this variety of tulip has a probability greater than 0.3 of producing red flowers.
Use a 10% level of significance and state your hypotheses clearly.

(5)

(a) $X \sim B(15, 0.25)$

$P(X > 4) = 1 - P(X \leq 4) = 1 - 0.6865 = 0.3135$

(b) $Y \sim B(n, 0.25)$ $\quad P(Y \geq 1) = 1 - P(Y = 0) > 0.95$

$1 - 0.75^n > 0.95 \quad \Rightarrow \quad 0.75^n < 0.05$

$n > \dfrac{\log 0.05}{\log 0.75} = 10.413...$

$n = 11$

(c) $T \sim B(100, 0.25)$, $np = 25$, $np(1-p) = 18.75$

Approximate by $W \sim N(25, 18.75)$

$P(21 < T \leq 30) \approx P(21.5 < W < 30.5)$ (continuity correction)

$= P\left(Z < \dfrac{30.5 - 25}{\sqrt{18.75}}\right) - P\left(Z < \dfrac{21.5 - 25}{\sqrt{18.75}}\right)$

$= P(Z < 1.27) - P(Z < -0.81)$

$= 0.8980 - (1 - 0.7910) = 0.8980 - 0.2090$

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Question 5 continued

$= 0.6890 \quad = 0.689$

(d) $H_0: p = 0.3 \qquad H_1: p > 0.3$

Under H_0, $R \sim B(25, 0.3)$

$P(R \geqslant 10) = 1 - P(R \leqslant 9) = 1 - 0.8106$

$= 0.1894 \quad > 0.10$

Not significant, so do not reject H_0

There is not significant evidence that the proportion of tulips producing red flowers is greater than 0.3

Question 5 continued

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Question 5 continued

(Total for Question 5 is 15 marks)

6. A rectangle $PQRS$ has a fixed perimeter of 40 cm.

The continuous random variable X cm represents the length of side PQ and is uniformly distributed over the interval [0, 20]

The continuous random variable A cm^2 represents the area of $PQRS$

(a) Find the value of E(A)

(6)

(b) Find the probability that the area of $PQRS$ is more than 5 times the area of a square whose side has length X cm.

(4)

(a) Side $QR = 20 - X$, so $A = X(20 - X) = 20X - X^2$

$X \sim U[0, 20]$: $E(X) = 10$, $\text{Var}(X) = \dfrac{(20-0)^2}{12} = \dfrac{100}{3}$

$E(X^2) = \text{Var}(X) + [E(X)]^2 = \dfrac{100}{3} + 10^2 = \dfrac{400}{3}$

$E(A) = 20E(X) - E(X^2) = 20 \times 10 - \dfrac{400}{3}$

$E(A) = \dfrac{200}{3} \quad (= 66.7)$

(b) $P(A > 5X^2) = P(20X - X^2 > 5X^2)$

$20X - 6X^2 > 0 \Rightarrow 2X(10 - 3X) > 0$

$\Rightarrow 0 < X < \dfrac{10}{3}$

$P\left(X < \dfrac{10}{3}\right) = \dfrac{1}{20} \times \dfrac{10}{3} = \dfrac{1}{6}$

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Question 6 continued

(Total for Question 6 is 10 marks)

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7. The continuous random variable X has probability density function

$$f(x) = \begin{cases} \frac{1}{4}x - \frac{1}{64}x^3 & 0 \leqslant x \leqslant 4 \\ 0 & \text{otherwise} \end{cases}$$

(a) Show that the median of X is 2.165 to 3 decimal places.

(5)

The continuous random variable Y has probability density function

$$f(y) = \begin{cases} \frac{4}{255}y^3 & 1 \leqslant y \leqslant 4 \\ 0 & \text{otherwise} \end{cases}$$

(b) Show that $\text{Var}\left(\frac{1}{Y}\right) = \frac{66}{7225}$

(*Solutions relying entirely on calculator technology are not acceptable.*)

(5)

(c) Hence find $\text{Var}\left(4 - \frac{5}{Y}\right)$

(2)

(a) $\int_0^m \left(\frac{1}{4}x - \frac{1}{64}x^3\right) dx = \frac{1}{2}$

$\left[\frac{1}{8}x^2 - \frac{1}{256}x^4\right]_0^m = \frac{1}{2} \Rightarrow \frac{m^2}{8} - \frac{m^4}{256} = \frac{1}{2}$

$32m^2 - m^4 = 128 \Rightarrow m^4 - 32m^2 + 128 = 0$

$m^2 = \frac{32 \pm \sqrt{32^2 - 4 \times 128}}{2} = 16 \pm \sqrt{128} = 4.686\ldots \text{ or } 27.31\ldots$

Since $0 \leq m \leq 4$, $m^2 \leq 16$, so $m^2 = 16 - \sqrt{128}$

$m^2 = 16 - 11.3137\ldots = 4.6862\ldots \Rightarrow m = \sqrt{4.6862\ldots}$

$m = 2.16478\ldots = 2.165$ (3 d.p.) as required

(b) $E\left(\frac{1}{Y}\right) = \int_1^4 \frac{1}{y} \times \frac{4}{255}y^3 \, dy = \frac{4}{255}\int_1^4 y^2 \, dy$

$= \frac{4}{255}\left[\frac{y^3}{3}\right]_1^4 = \frac{4}{255} \times \frac{64 - 1}{3} = \frac{4}{255} \times 21 = \frac{28}{85}$

$E\left(\frac{1}{Y^2}\right) = \int_1^4 \frac{1}{y^2} \times \frac{4}{255}y^3 \, dy = \frac{4}{255}\int_1^4 y \, dy$

$= \frac{4}{255}\left[\frac{y^2}{2}\right]_1^4 = \frac{4}{255} \times \frac{16 - 1}{2} = \frac{30}{255} = \frac{2}{17}$

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Question 7 continued

$$\text{Var}\left(\frac{1}{Y}\right) = E\left(\frac{1}{Y^2}\right) - \left[E\left(\frac{1}{Y}\right)\right]^2 = \frac{2}{17} - \left(\frac{28}{85}\right)^2$$

$$= \frac{850}{7225} - \frac{784}{7225} = \frac{66}{7225} \quad \text{as required}$$

(c) $$\text{Var}\left(4 - \frac{5}{Y}\right) = (-5)^2 \text{Var}\left(\frac{1}{Y}\right) = 25 \times \frac{66}{7225}$$

$$= \frac{66}{289} = 0.22837\ldots = 0.228$$

Question 7 continued

(Total for Question 7 is 12 marks)

TOTAL FOR PAPER IS 75 MARKS

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