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INTERNATIONAL A LEVEL MATHEMATICS • STATISTICS 1 (WST01)

Statistics 1 Practice Paper 3

Mark Scheme

AIMING FOR A/A*

Written in the style of the Pearson Edexcel International Advanced Level paper (WST01/01) • 75 marks

Every question marked line by line the way an examiner marks it, with notes on the common errors

Mark every line, not just the answer. Method marks are given for a correct method even when the final answer is wrong. If you lost marks, find the *first* line where your working differs from the scheme. That is the thing to fix.

Code	Meaning
M1	Method mark: for knowing a correct method and attempting to apply it. Small slips in the working do not lose this mark.
dM1	Dependent method mark: can only be given if the method mark before it has been given.
A1	Accuracy mark: for a correct answer or line of working. It depends on the method mark before it.
B1	Independent mark: for a correct result or statement, whatever method was used.
*	The answer is given in the question. Every step must be shown, and the answer must follow from correct working (cso).
cao / cso	Correct answer only / correct solution only, with no errors anywhere in the working.
ft / oe	Follow through from your own earlier answer / or any correct equivalent form.
awrt	Answers which round to the value given, so $-0.9637\ldots$ earns "awrt -0.964".

Normal distribution: show the standardisation. Write $z = (x - \mu)/\sigma$ with the numbers in, then use the tables: probabilities to 4 decimal places, and percentage points such as 1.6449 and 2.3263 to 4 decimal places. A calculator answer with no standardisation shown can lose the method marks.

Rough grade guide (out of 75): A **53** • B **44** • C **35**

Based on recent WST01 grade boundaries. Real boundaries change every series, so treat this as a guide, not a grade.

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What to revise next

Write in your score for each question. Where you dropped marks, tap the chapter to practise ten more exam questions on it.

Q	What it tested	Marks	Practise it	Score
1	A probability function from a cumulative distribution function; E(X) and Var(X) with an unknown n	12	Ch 6 Discrete Random Variables	
2	Grouped ages: class boundaries, missing frequencies, interpolation, a histogram scale and coding	13	Ch 2 Location and Spread Ch 3 Representations of Data	
3	Independence leading to a quadratic; conditional probability	12	Ch 4 Probability	
4	Regression with a negative coding: the sign of r and which line to use	13	Ch 5 Correlation and Regression Ch 2 Location and Spread	
5	Normal parameters from tail areas; a symmetric interval; rounded data	12	Ch 7 The Normal Distribution	
6	A back-to-back stem and leaf diagram, outliers, box plots and skewness	13	Ch 3 Representations of Data Ch 2 Location and Spread	
	Total	**75**		

Where did the marks go? If you lost the first marks of a question, the method needs work: go back to that chapter's key skills page. If you lost the final marks, the method is fine and the gap is the trap: a class boundary, a root to reject, a sign reversed by coding, a value rounded to the nearest unit, or a diagram read backwards. At grade A* the method is rarely the problem; checking every answer against the question is.

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Question 1

12 marks

Part	Scheme	Marks
(a)	$P(X = x) = F(x) - F(x-1)$ $= \frac{x(x+1) - (x-1)x}{n(n+1)}$ $= \frac{x^2 + x - x^2 + x}{n(n+1)} = \frac{2x}{n(n+1)}$ *Using $P(X = x) = F(x)$ scores M0: F is cumulative.*	M1 M1 A1* (3)
(b)	$E(X) = \sum \frac{2x^2}{n(n+1)}$ $= \frac{2}{n(n+1)} \times \frac{n(n+1)(2n+1)}{6}$ $= \frac{2n+1}{3}$ $\frac{2n+1}{3} = 7$: $\boxed{n = 10}$	M1 M1 A1 A1 (4)
(c)	$E(X^2) = \sum \frac{2x^3}{n(n+1)} = \frac{2}{n(n+1)} \times \frac{n^2(n+1)^2}{4} = \frac{n(n+1)}{2}$ $= 55$ $\text{Var}(X) = 55 - 7^2 = \boxed{6}$	M1 A1 A1 (3)
(d)	$P(X > 7) = 1 - F(7) = 1 - \frac{56}{110}$ $\boxed{\frac{27}{55}}$ *$X > 7$ means $X \geqslant 8$, so the complement is $F(7)$, not $F(8)$.*	M1 A1 (2)
		Total for Question 1: 12 marks

Question 2

13 marks

Part	Scheme	Marks
(a)	Ages in completed years: 10–19 means $10 \leqslant$ age < 20, so midpoints 15, 25, 35, 45, 60	**B1**
	$12 + a + 22 + b + 8 = 80$, so $a + b = 38$	**M1**
	$15 \times 12 + 25a + 35 \times 22 + 45b + 60 \times 8 = 32.5 \times 80 = 2600$	**M1**
	$\boxed{a = 27}$, $\boxed{b = 11}$	**A1**
	Midpoints 14.5, 24.5, ... (as if the data were rounded) give $a = 25$, $b = 13$: B0 M1 M1 A0.	**(4)**
(b)	The 40th value is in 30–39, whose boundaries are 30 and 40	**B1**
	$30 + \dfrac{40 - 39}{22} \times 10$	**M1**
	$\boxed{30.5}$ (awrt)	**A1**
		(3)
(c)	Frequency density $27 \div 10 = 2.7$ is drawn as 5.4 cm, so 2 cm per unit; $8 \div 20 = 0.4$	**M1**
	$\boxed{0.8\,\text{cm}}$	**A1**
	The class 50–69 is 20 years wide. Using a width of 10 gives 1.6 cm.	**(2)**
(d)	$\bar{y} = \dfrac{32.5 - 35}{5} = -0.5$ (or $\sum fy = -40$)	**M1**
	$\text{Var}(y) = \dfrac{544}{80} - (-0.5)^2 = 6.55$	**M1**
	$\sigma_x = 5\sqrt{6.55}$	**M1**
	$\boxed{12.8}$ years (awrt)	**A1**
		(4)
		Total for Question 2: 13 marks

Question 3

12 marks

Part	Scheme	Marks
(a)	$P(A) = 0.2 + p$ and $P(B) = 0.3 + p$ Independence: $p = (0.2 + p)(0.3 + p)$ $p^2 - 0.5p + 0.06 = 0$ $(p - 0.2)(p - 0.3) = 0$, so $p = 0.2$ or $p = 0.3$ $r = 1 - (0.2 + p + 0.3 + 0.25) = 0.25 - p$, which is negative when $p = 0.3$, so $\boxed{p = 0.2}$ *Both roots satisfy the equation. The reason for rejecting 0.3 must refer to a probability that would be negative (or to a total above 1).*	**M1** **M1** **A1** **A1** **B1** **(5)**
(b)	$\boxed{r = 0.05}$	**B1** **(1)**
(c)	$\dfrac{P(A)}{P(A \cup B)} = \dfrac{0.4}{0.7}$ $\boxed{\dfrac{4}{7}}$	**M1** **A1** **(2)**
(d)	$P(A' \cap B') = 0.25 + 0.05 = 0.3$ and $P(A') = 0.6$ $\boxed{0.5}$ *This equals $P(B')$, as it must: if A and B are independent, so are A' and B'*	**M1** **A1** **(2)**
(e)	$2 \times 0.7 \times 0.3$ $\boxed{0.42}$	**M1** **A1** **(2)**
		Total for Question 3: 12 marks

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Question 4

13 marks

Part	Scheme	Marks
(a)	$S_{pp} = 684 - \frac{36^2}{9}$	M1
	Two of $S_{pp} = 540$, $S_{qq} = 54$, $S_{pq} = 169.5$	A1
	All three correct	A1
		(3)
(b)	$r_{pq} = \frac{169.5}{\sqrt{540 \times 54}}$	M1
	$= 0.9926\ldots$	A1
	q decreases as T increases, so the sign changes: $\boxed{-0.993}$ (awrt)	B1
	Coding does not change the size of r, but dividing by a negative (here T has coefficient $-\frac{1}{2}$) reverses its sign. The scatter diagram also shows a negative correlation.	
		(3)
(c)	$b_q = \frac{169.5}{540} = 0.31389\ldots$	M1
	$\bar{p} = 4$, $\bar{q} = \frac{14}{3}$: $q = 3.411\ldots + 0.31389\ldots p$	M1
	$\frac{30 - T}{2} = 3.411 + 0.31389\left(\frac{h - 1000}{100}\right)$	M1
	$30 - T = 0.544 + 0.0062778h$	M1
	$\boxed{T = 29.5 - 0.00628h}$	A1
		(5)
(d)	The temperature falls by about 0.628 ℃ for every 100 m increase in altitude (oe, 6.28 ℃ per km)	B1
		(1)
(e)	h is the explanatory variable: to estimate h from T you need the regression line of h on T	B1
		(1)
		Total for Question 4: 13 marks

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Question 5

12 marks

Part	Scheme	Marks
(a)	$1 - 0.0668 = 0.9332$, so from the table $z = -1.5$	**B1**
	$1 - 0.2266 = 0.7734$, so $z = 0.75$	**B1**
	$\frac{46-\mu}{\sigma} = -1.5$ and $\frac{64-\mu}{\sigma} = 0.75$	**M1**
	Subtracting: $18 = 2.25\sigma$	**M1**
	$\boxed{\sigma = 8}$, $\boxed{\mu = 58}$	**A1**
	Neither 0.0668 nor 0.2266 is in the percentage points table: the main table has to be read backwards.	**(5)**
(b)	$P(X < \mu + k) = 0.95$	**M1**
	$\frac{k}{8} = 1.6449$	**M1**
	$\boxed{k = 13.2}$ (awrt)	**A1**
	Using 1.2816 (from 0.9 instead of 0.95) gives 10.3: the 10% outside is split between the two tails.	**(3)**
(c)	A recorded 60 means $59.5 \leqslant X < 60.5$: $P(0.19 < Z < 0.31) = 0.6217 - 0.5753$	**M1**
	$\boxed{0.0464}$ (awrt 0.046)	**A1**
		(2)
(d)	$\frac{P(X > 70)}{P(X > 59.5)} = \frac{0.0668}{0.4247}$	**M1**
	$\boxed{0.157}$ (awrt)	**A1**
	"At least 60" when recorded means $X \geqslant 59.5$. Using $X > 60$ gives 0.166.	**(2)**
		Total for Question 5: 12 marks

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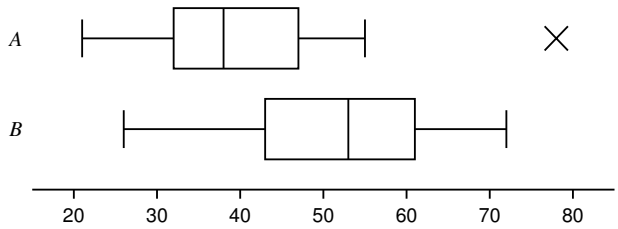
Question 6

13 marks

Part	Scheme	Marks
(a)	$n = 15$: the 4th, 8th and 12th values, reading the left-hand leaves outwards from the stem	M1
	Group A: $\boxed{Q_1 = 32,\ Q_2 = 38,\ Q_3 = 47}$	A1
	Group B: $\boxed{Q_1 = 43,\ Q_2 = 53,\ Q_3 = 61}$	A1
	On the left the key is reversed: $8 \mid 2$ is 28, not 82. Reading the leaves the wrong way gives impossible values.	(3)
(b)	A: $47 + 1.5 \times 15 = 69.5$ and $32 - 22.5 = 9.5$; B: $61 + 1.5 \times 18 = 88$ and $43 - 27 = 16$	M1
	78 is the only value of A above 69.5; all of B lies between 16 and 88	A1
		(2)
(c)		B1
	Box plot for A: box 32, 38, 47	B1
	Box plot for B: box 43, 53, 61, whiskers to 26 and 72	B1
	A: whiskers to 21 and 55, with 78 marked as an outlier	(3)
(d)	The median for B (53) is higher than for A (38): group B generally took longer	B1
	B has the larger IQR (18 against 15), but A has an outlier and is positively skewed (oe)	B1
		(2)
(e)	Mean $= \dfrac{607}{15} = 40.47$; s.d. $= \sqrt{\dfrac{27331}{15} - 40.47^2} = 13.58$	M1
	$\dfrac{3(40.47 - 38)}{13.58}$	M1
	$\boxed{0.545}$ (awrt 0.54 or 0.55): positive skew, so a normal distribution (which is symmetrical) is not a suitable model	A1
		(3)
		Total for Question 6: 13 marks

TOTAL FOR PAPER: 75 MARKS