WST01/01: Statistics S1

Question Number		Scheme	Marks
Q1	(a)	$r = \dfrac{8825}{\sqrt{1022500 \times 130.9}}$, = awrt **0.763**	M1 A1 (2)
	(b)	Teams with high attendance scored more goals (oe, statement in context)	B1 (1)
	(c)	0.76(3)	B1ft (1)
			Total 4
	(a)	M1 for a correct expression, square root required Correct answer award 2/2	
	(b)	Context required (attendance and goals). Condone causality. B0 for 'strong positive correlation between attendance and goals' on its own oe	
	(c)	Value required. Must be a correlation coefficient between -1 and +1 inclusive. B1ft for 0.76 or better or same answer as their value from part (a) to at least 2 d.p.	

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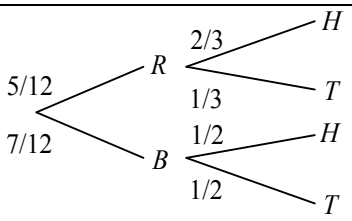
Q2 (a)	 P(*R*) and P(*B*) 2nd set of probabilities	B1 B1 (2)
(b)	$P(H) = \frac{5}{12}\times\frac{2}{3}+\frac{7}{12}\times\frac{1}{2}, = \frac{41}{72}$ or awrt 0.569	M1 A1 (2)
(c)	$P(R\|H) = \frac{\frac{5}{12}\times\frac{2}{3}}{"\frac{41}{72}"}, = \frac{20}{41}$ or awrt 0.488	M1 A1ft A1 (3)
(d)	$\left(\frac{5}{12}\right)^2+\left(\frac{7}{12}\right)^2$ $= \frac{25}{144}+\frac{49}{144} = \frac{74}{144}$ or $\frac{37}{72}$ or awrt 0.514	M1 A1ft A1 (3) **Total 10**

(a) 1st B1 for the probabilities on the first 2 branches. Accept $0.41\dot{6}$ and $0.58\dot{3}$

2nd B1 for probabilities on the second set of branches. Accept $0.\dot{6}$, $0.\dot{3}$, 0.5 and $\frac{1.5}{3}$

Allow exact decimal equivalents using clear recurring notation if required.

(b) M1 for an expression for P(*H*) that follows through their sum of two products of **probabilities** from their tree diagram

(c)

Formula seen M1 for $\frac{P(R\cap H)}{P(H)}$ with denominator their (b) substituted e.g. $\frac{P(R\cap H)}{P(H)} = \frac{\frac{5}{12}}{(\text{their (b)})}$ award M1.

Formula not seen M1 for $\frac{\text{probability}\times\text{probability}}{\text{their } b}$ but M0 if fraction repeated e.g. $\frac{\frac{5}{12}\times\frac{2}{3}}{\frac{2}{3}}$.

1st A1ft for a fully correct expression or correct follow through

2nd A1 for $\frac{20}{41}$ o.e.

(d) M1 for $\left(\frac{5}{12}\right)^2$ or $\left(\frac{7}{12}\right)^2$ can follow through their equivalent values from tree diagram

1st A1 for both values correct or follow through from their original tree and +

2nd A1 for a correct answer

Special Case $\frac{5}{12}\times\frac{4}{11}$ or $\frac{7}{12}\times\frac{6}{11}$ seen award M1A0A0

Question Number		Scheme	Marks
Q3	(a)	$2a+\frac{2}{5}+\frac{1}{10}=1$ (or equivalent)	M1
		$a=\frac{1}{4}$ **or 0.25**	A1 (2)
	(b)	E(X) = **1**	B1 (1)
	(c)	E(X^2) $=1\times\frac{1}{5}+1\times\frac{1}{10}+4\times\frac{1}{4}+9\times\frac{1}{5}$ (= 3.1)	M1
		Var(X) = $3.1-1^2$, **= 2.1 or** $\frac{21}{10}$ **oe**	M1 A1 (3)
	(d)	Var(Y) = $(-2)^2$ Var(X), = **8.4 or** $\frac{42}{5}$ **oe**	M1 A1 (2)
	(e)	$X \geq Y$ when X = 3 or 2, so probability = "$\frac{1}{4}$"+$\frac{1}{5}$	M1 A1ft
		= $\frac{9}{20}$ **oe**	A1 (3)
			Total 11

(a) M1for a clear attempt to use $\sum P(X=x)=1$
Correct answer only 2/2.
NB Division by 5 in parts (b), (c) and (d) seen scores 0. Do not apply ISW.

(b) B1 for 1

(c) 1st M1 for attempting $\sum x^2 P(X=x)$ at least two terms correct. Can follow through.
2nd M1 for attempting E(X^2) $-$ [E(X)]^2 or allow subtracting 1 from their attempt at E(X^2) provided no incorrect formula seen.
Correct answer only 3/3.

(d) M1 for $(-2)^2$ Var(X) or 4Var(X)
Condone missing brackets provided final answer correct for their Var(X) .
Correct answer only 2/2.

(e) Allow M1 for distribution of $Y=6-2X$ and correct attempt at E(Y^2) $-$ [E(Y)]^2
M1 for identifying X = 2, 3
1st A1ft for attempting to find their P(X=2) + P(X = 3)
2nd A1 for $\frac{9}{20}$ or 0.45

Question Number		Scheme	Marks
Q4	(a)	$\frac{2+3}{\text{their total}} = \frac{5}{\text{their total}} = \frac{1}{6}$ **(** given answer**)**	M1 A1cso (2)
	(b)	$\frac{4+2+5+3}{\text{total}}, \quad = \frac{14}{30}$ or $\frac{7}{15}$ or $0.4\dot{6}$	M1 A1 (2)
	(c)	$P(A \cap C) = 0$	B1 (1)
	(d)	$P(C \mid \text{reads at least one magazine}) = \frac{6+3}{20} = \frac{9}{20}$	M1 A1 (2)
	(e)	$P(B) = \frac{10}{30} = \frac{1}{3}$, $P(C) = \frac{9}{30} = \frac{3}{10}$, $P(B \cap C) = \frac{3}{30} = \frac{1}{10}$ or $P(B\|C) = \frac{3}{9}$	M1
		$P(B) \times P(C) = \frac{1}{3} \times \frac{3}{10} = \frac{1}{10} = P(B \cap C)$ or $P(B\|C) = \frac{3}{9} = \frac{1}{3} = P(B)$	M1
		So yes they are statistically independent	A1cso (3)
			Total 10

(a)	M1 for $\frac{2+3}{\text{their total}}$ or $\frac{5}{30}$
(b)	M1 for adding at least 3 of "4, 2, 5, 3" and dividing by their total to give a probability Can be written as separate fractions substituted into the completely correct Addition Rule
(c)	B1 for 0 or 0/30
(d)	M1 for a **denominator of 20** or $\frac{20}{30}$ leading to an answer with denominator of 20 $\frac{9}{20}$ only, 2/2
(e)	1st M1 for attempting all the required probabilities for a suitable test 2nd M1 for use of a correct test - must have attempted all the correct probabilities. Equality can be implied in line 2. A1 for fully correct test carried out with a comment

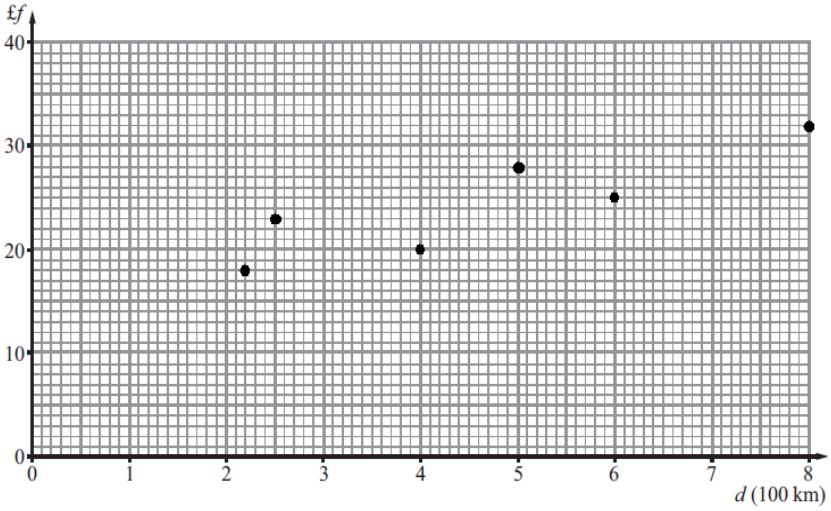
Question Number		Scheme	Marks
Q5	**(a)**	23, 35.5 (may be in the table)	B1 B1 (2)
	(b)	Width of 10 units is 4 cm so width of 5 units is **2 cm**	B1
		Height = 2.6×4=**10.4 cm**	M1 A1 (3)
	(c)	$\sum fx = 1316.5 \Rightarrow \bar{x} = \frac{1316.5}{56} =$ awrt **23.5**	M1 A1
		$\sum fx^2 = 37378.25$ can be implied	B1
		So $\sigma = \sqrt{\frac{37378.25}{56} - \bar{x}^2} =$ awrt**10.7** allow s = 10.8	M1 A1 (5)
	(d)	$Q_2 = (20.5) + \frac{(28-21)}{11}\times5 = 23.68\ldots$ **awrt 23.7 or 23.9**	M1 A1 (2)
	(e)	$Q_3 - Q_2 = 5.6,\quad Q_2 - Q_1 = 7.9$ (or $\bar{x} < Q_2$)	M1
		[7.9 >5.6 so] **negative skew**	A1 (2)
			Total 14

(b) M1 for their width x their height=20.8.
Without labels assume width first, height second and award marks accordingly.

(c) 1st M1 for reasonable attempt at $\sum x$ and /56
2nd M1 for a method for σ or s, $\sqrt{}$ is required
Typical errors $\sum(fx)^2 = 354806.3$ M0, $\sum f^2x = 13922.5$ M0 and $(\sum fx)^2 = 1733172$ M0
Correct answers only, award full marks.

(d) Use of $\sum f(x-\bar{x})^2 =$ awrt 6428.75 for B1
lcb can be 20, 20.5 or 21, width can be 4 or 5 and the fraction part of the formula correct for M1 - Allow 28.5 in fraction that gives awrt 23.9 for M1A1

(e) M1for attempting a test for skewness using quartiles or mean and median.
Provided median greater than 22.55 and less than 29.3 award for M1 for $Q_3 - Q_2 < Q_2 - Q_1$ without values as a valid reason.
SC Accept mean close to median and no skew oe for M1A1

Question Number	Scheme	Marks
Q6 (a)		B1 B1 (2)
(b)	The **points** lie reasonably close to a straight **line** (o.e.)	B1 (1)
(c)	$\sum d = 27.7, \quad \sum f = 146$ (both, may be implied)	B1
	$S_{dd} = 152.09 - \frac{(27.7)^2}{6} = 24.208\ldots$ **awrt <u>24.2</u>**	M1 A1
	$S_{fd} = 723.1 - \frac{27.7\times146}{6} = 49.06\ldots$ **awrt <u>49.1</u>**	A1 (4)
(d)	$b = \frac{S_{fd}}{S_{dd}} = 2.026\ldots$ **awrt <u>2.03</u>**	M1 A1
	$a = \frac{146}{6} - b\times\frac{27.7}{6} = 14.97\ldots$ so ***<u>f = 15.0 + 2.03d</u>***	M1 A1 (4)
(e)	A flight costs **£2.03 (or about £2)** for every extra **100km** or about **2p** per **km**.	B1ft (1)
(f)	$15.0 + 2.03d < 5d$ so $d > \frac{15.0}{(5-2.03)} = 5.00 \sim 5.05$	M1
	So $t >$ 500~505	A1 (2)
		Total 14

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(a)	1st B1 for at least 4 points correct (allow ± one 2mm square) 2nd B1 for all points correct (allow ± one 2 mm square
(b)	Ignore extra points and lines Require reference to points and line for B1.
(c)	M1 for a correct method seen for either - a correct expression 1st A1 for S_{dd} awrt 24.2 2nd A1 for S_{fd} awrt 49.1
(d)	1st M1 for a correct expression for b - can follow through their answers from (c) 2nd M1 for a correct method to find a - follow through their b and their means 2nd A1 for f =.... in terms of d and all values awrt given expressions. Accept 15 as rounding from correct answer only.
(e)	Context of cost and distance required. Follow through their value of b
(f)	M1 for an attempt to find the intersection of the 2 lines. Value of t in range 500 to 505 seen award M1. Value of d in range 5 to 5.05 award M1. Accept t greater than *500* to 505 inclusive to include graphical solution for M 1A1

Question Number	Scheme	Marks
Q7 (a)	$P(D > 20) = P\left(Z > \frac{20-30}{8}\right)$	M1
	$= P(Z > -1.25)$	A1
	$= \underline{\mathbf{0.8944}}$ **awrt 0.894**	A1 (3)
(b)	$P(D < Q_3) = 0.75$ so $\frac{Q_3 - 30}{8} = 0.67$	M1 B1
	$Q_3 =$ **awrt** $\underline{\mathbf{35.4}}$	A1 (3)
(c)	35.4 - 30= 5.4 so $Q_1 = 30 - 5.4$ = **awrt** $\underline{\mathbf{24.6}}$	B1ft (1)
(d)	$Q_3 - Q_1 = 10.8$ so $1.5(Q_3 - Q_1) = 16.2$ so $Q_1 - 16.2 = h$ or $Q_3 + 16.2 = k$	M1
	h=**8.4 to 8.6** and k= **51.4 to 51.6** both	A1 (2)
(e)	$2P(D > 51.6) = 2P(Z > 2.7)$	M1
	$= 2[1 - 0.9965]$ = awrt **0.007**	M1 A1 (3)
		Total 12

(a) M1 for an attempt to standardise 20 or 40 using 30 and 8.
1st A1 for $z = \pm 1.25$
2nd A1 for awrt 0.894

(b) M1 for $\frac{Q_3 - 30}{8}$ = to a z value
M0 for 0.7734 on RHS.
B1 for (z value) between 0.67~0.675 seen.
M1B0A1 for use of $z = 0.68$ in correct expression with awrt 35.4

(c) Follow through using their of quartile values.

(d) M1 for an attempt to calculate 1.5(IQR) and attempt to add or subtract using one of the formulae given in the question - follow through their quartiles

(e) 1st M1 for attempting 2P(D > their k) or (P(D >their k)+ P(D < their h))
2nd M1 for standardising their h or k (may have missed the 2) so allow for standardising P(D > 51.6) or P(D < 8.4)
Require boths Ms to award A mark.