Mark Scheme (Results)

Summer 2017

Pearson Edexcel International A Level
in Statistics S1 (WST01/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL IAL MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

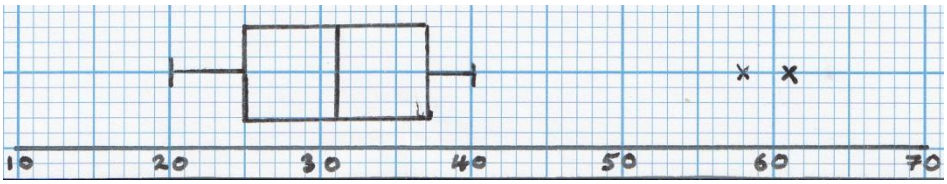
4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. Ignore wrong working or incorrect statements following a correct answer.

Question		Scheme	Marks
1.	**(a)**	$[Q_2 =] \quad (59.5) + \frac{10}{22} \times 5$	M1
		$= 61.7727\ldots$ awrt **<u>61.8</u>**	A1
			(2)
	(b)	$[\bar{x} =] \frac{\sum fx}{50} = \frac{3085}{50}$	M1
		$=$ **<u>61.7</u>**	A1cao
			(2)
	(c)	$[\sigma_x =] \sqrt{\frac{192\,102.5}{50} - \bar{x}^2} = \sqrt{35.16}$	M1
		$= 5.929586\ldots$ awrt **<u>5.93</u>**	A1
			(2)
	(d)	[Interpolation from above]	
		$\frac{4.5}{10} \times 13$ (= 5.85)	M1
		So probability is $\frac{5.85}{50} =$ **<u>0.117</u>**	A1cao
			(2)
			(8 marks)

	Notes
(a)	M1 for a correct expression (oe) without endpoint. Allow "n+1" so e.g. $(59.5) + \frac{10.5}{22} \times 5$ Allow working down e.g. $(64.5) - \frac{12}{22} \times 5$ Allow $\frac{m - 59.5}{64.5 - 59.5} = \frac{25 - 15}{37 - 15}$ oe for M1 A1 for awrt 61.8 or, if (n + 1) is used, allow awrt 61.9
(b)	M1 for a correct expression for the mean $\frac{49.5 \times 5 + 57 \times 10 + 62 \times 22 + 69.5 \times 13}{50}$ <u>or</u> an attempt at $\frac{\sum fx}{50}$ with at least 3 correct products <u>or</u> $\frac{3000 \leq \sum fx \leq 3200}{50}$ A1 for 61.7 from correct working
(c)	M1 for a correct expression including square root. Ft their 61.7. Allow use of s A1 for awrt 5.93 Allow s = 5.989787… = awrt 5.99
(d)	M1 for $\frac{4.5}{10} \times 13$ (use of interpolation to find the number of carrots weighing more than 70g) (may be implied by sight of 5.85 may also be implied by 50 – 44.15 (Allow 50 – 44 (=6) or 50 – 45 (=5) coming from 44.15 or 44.2 seen in working to score M1) A1 for an answer of 0.117 Note: Use of normal distribution scores M0A0.

Question	Scheme	Marks
2. (a)	[Range = 61 – 20 =] **41**	B1 (1)
(b)	[IQR = 37 – 25 =] **12**	B1 (1)
(c)	$Q_3 - Q_2 = Q_2 - Q_1$ [= 6] or 37 – 31 = 31 – 25 So **symmetric** or **no skew**	M1 A1 (2)
(d)	$r = \dfrac{10}{\sqrt{5514 \times 1145.6}}$ = 0.0039787… **0.004** or awrt **0.0040**	M1 A1 (2)
(e)	Value of *r* is **close to zero** or **no correlation** or **(very) weak correlation** So Chetna's belief is **not supported**	B1 dB1 (2)
(f)	Check upper outlier limit: 37 + 1.5×"12"(= 55) Adam's change won't affect median or upper quartile Betty's change now becomes a 2nd outlier Upper whisker stays the same  	M1 M1 A1 (3)
		(11 marks)

	Notes
(c)	M1 for attempting to compare $Q_3 - Q_2$ with $Q_2 - Q_1$ or a description in words that median in middle of box A1 for "symmetric" or "no skew" Note: 'No skew' on its own is M0A0.
(d)	M1 for a correct expression for *r* A1 for 0.004 or awrt 0.0040 (0.0039 is A0) (Allow answers in standard form).
(e)	1st B1 for a comment about correlation being small, close to 0 or (very) weak 2nd dB1 dep. on 1st B1 for a comment stating lack of support for Chetna's belief (accept 'No' as equivalent to 'not supported'). Note: $\|r\| > 1$ scores B0B0 in (e). '*r* is far from 1' on its own scores B0B0
(f)	1st M1 for calculating the upper limit for outliers (ft their IQR from (b)) [37 × 1.5 is M0] 2nd M1 for a box and 1 upper whisker and 1 lower whisker and: 20, 25, 31, 37 as before (this must be drawn on the grid) A1 dependent on at least 1 M1 mark for exactly 1 upper whisker, still at 40, and two outliers: one at 58 and one at 61 Note: A fully correct box plot with both outliers correct but no working scores M0M1A1 2 upper whiskers scores a maximum of M1M0A0

Question	Scheme	Marks
3. (a)	[Let J = the length of a jump] $P(J < 2.5) = P\left(Z < \frac{2.5-3.3}{0.6}\right)$	M1
	$= P(Z < -1.333\ldots) = 1 - 0.9082$	dM1
	$= \mathbf{0.0912 \sim 0.0918}$	A1
		(3)
(b)	$\left[P(J > d) = 0.4 \Rightarrow\right]$ $\frac{d-3.3}{0.6} = 0.2533$	M1 A1
	d = awrt **3.452**	A1
		(3)
(c)	$\left[P(J > m \mid J > d) \Rightarrow\right]$ $\frac{P(J > m)}{0.4} = 0.5$ or $P(J > m) = 0.2$	M1
	$\frac{m-3.3}{0.6} = 0.8416$	M1
	So m = 3.80496 (calc 3.80497274…) awrt **3.80**	A1
		(3)
(d)	$P(J > 4.1) = 0.0918$ (same as (a))	B1ft
	So P(certificate) = $0.4 \times$"(a)"	M1
	$= \mathbf{0.036 \sim 0.037}$	A1
		(3)
		(12 marks)

	Notes
(a)	1st M1 for standardising with 2.5, 3.3 and 0.6 Allow $\pm$ 2nd M1 dep on 1st M1 for attempting $1 - p$ where $0.5 < p < 1$ A1 for an answer in the range 0.0912~0.0918 NB calc gives 0.09121128…
(b)	M1 for standardising with "d", 3.3 and 0.6 and setting equal to z $(0.2 < \lvert z \rvert < 0.3)$ 1st A1 for a correct equation with compatible signs with z = 0.25 or better, i.e. 0.253 or 0.2533… 2nd A1 for awrt 3.452 (calc gives 3.45200856… use of 0.2533 gives 3.45198)
(c)	1st M1 for a correct probability statement involving 'J' and 'm'(median) only (may be implied by 2nd M1). Use the letter in the standardisation as the one representing the median. 2nd M1 for $\frac{m-3.3}{0.6} = z$ (with compatible signs) where $0.84 \leq z \leq 0.85$ A1 for awrt 3.80 (accept 3.805)
(d)	B1ft for an answer in range 0.0912~0.0918 or the same as part (a) for $P(J > 4.1)$ M1 for $0.4 \times$ their $P(J > 4.1)$ A1 for answer in the range 0.036~0.037 (No fractions) NB $0.4 \times 0.0918 = 0.036712$ and $0.4 \times 0.0912 = 0.03648$

Question	Scheme	Marks
4. (a)	$0.4p + 0.15(1-p) = 0.26$	M1
	$0.25p = 0.11$	dM1
	$p = \underline{\mathbf{0.44}}$	A1
		(3)
(b)	$\frac{"0.56"q}{"0.56"q+"0.44"\times 0.6} = 0.175$	M1A1ft
	$0.462q = 0.0462$	dM1
	$q = \underline{\mathbf{0.1}}$	A1
		(4)
(c)	$P(C) = (1-p)\times(1-0.15-q) =$ "0.56" × "0.75"	M1
	$= \underline{\mathbf{0.42}}$	A1
		(2)
(d)	$[P(R\mid C') =] \quad \frac{P(R)}{P(C')} = \frac{(a)}{1-(c)} = \frac{"0.44"}{"0.58"}$	M1
		M1
	$= \frac{22}{29} = 0.75862\ldots$ or awrt $\underline{\mathbf{0.759}}$	A1
		(3)
		(12 marks)

Notes

(a)

1st M1 for attempt at correct equation for p (Must have at least 2 terms in p) **and** must be set equal to 0.26

2nd dM1 dep on 1st M1 for solving their linear equation in p by reducing to $Ap = B$ with at least 1 of A or B correct

A1 for $p = 0.44$ (or exact equivalent e.g. $\frac{11}{25}$)

(b)

1st M1 for a probability ratio of the form $\frac{rq}{rq+(1-r)\times 0.6}$

1st A1ft for $r = 1 -$ their p and the $= 0.175$

2nd dM1 dep on 1st M1 for rearranging their equation into the form $Aq = B$ with at least 1 of A or B correct or correct ft

2nd A1 for $q = 0.1$ or an exact equivalent

(c)

M1 for (1 – their p) × (1 – 0.15 – their q)

A1 for 0.42 or an exact equivalent

(d)

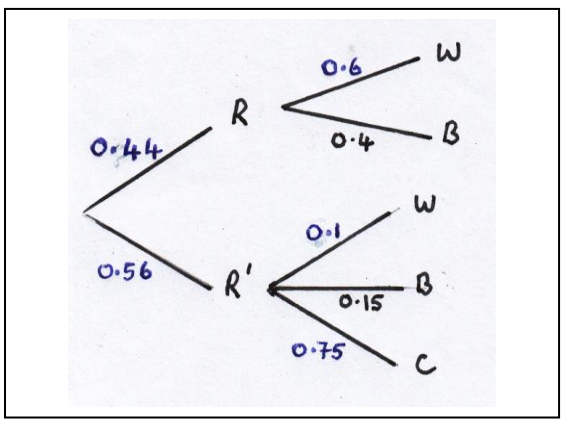
1st M1 for a ratio of **probabilities** with 0.44 or 'their (a)' on num.

2nd M1 for a ratio of **probabilities** with 0.58 or '1 – their (c)' on denom.

A1 for $\frac{22}{29}$ or awrt 0.759

Correct answer only scores 3 out of 3.

Note: If correct ft on num. and denom. leads to "num" > "denom" then maximum score is M0M1A0)



Question	Scheme	Marks
5. (a)	$[S_{ss} =]\ \ 44.22 - \frac{15^2}{9}$; = 19.22 or awrt **19.2**	M1; A1 (2)
(b)	*r* is **close to 1** so **supports** use of a linear model	B1 (1)
(c)	("hours of sunshine" would be explanatory) since *t* depends on *s*	B1 (1)
(d)	$(r =)\ 0.832 = \frac{S_{st}}{\sqrt{S_{ss} \times S_{tt}}}$ or $0.832 = \frac{S_{st}}{\sqrt{"19.22" \times 10.89}}$	M1
	$S_{st} = 0.832 \times \sqrt{"19.22" \times 10.89}$	dM1
	So S_{st} = 12.03688… awrt **12.0**	A1 (3)
(e)	$b = \frac{"12.036..."}{"19.22"}$, = 0.62626… [awrt 0.62 or 0.63]	M1, A1ft
	$a = \bar{t} - "0.6262..." \times \bar{s} = 14.\dot{1} - "0.6262..." \times 1.\dot{6}$	M1
	t* = 13.1 + 0.626*s	A1 (4)
(f)	$\sigma_s = \left(\sqrt{\frac{S_{ss}}{9}}$ or $\sqrt{\frac{44.22}{9} - \left(\frac{15}{9}\right)^2} \right) = 1.461\ldots$ awrt **1.46**	B1 (1)
(g)	$[13.1 + 0.626 \times 5]$ = 16.2… awrt **16.2**	B1 (1)
(h)	$\bar{s} = 1.666...$ and $\sigma_s = 1.46\ldots$ so $1.666\ldots + 2 \times 1.46\ldots (= 4.586)$	M1
	s = 5 is > 2 sd above the mean so it is outside the range therefore estimate is **unreliable**	A1ft (2)
		(15 marks)

Notes

(a) M1 for a correct expression
A1 for 19.22 or awrt 19.2

(b) B1 for a comment that supports the use with a reason based on the value of *r*
Allow **strong (correlation) supports** use of linear model.
(Allow Yes, since strong correlation)

(c) B1 for a suitable reason which states that *t* is dependent (oe) upon *s*
e.g. 'Sunshine affects temperature' , 'Sunshine influences temperature', etc.

(d) 1st M1 for using the value of *r* to form an equation for S_{st}
2nd dM1 dep on 1st M1 for rearranging into the form S_{st} = … (may be implied by correct answer or correct ft answer)

(e) 1st M1 for a correct expression for the gradient (ft $\frac{\text{their } d}{\text{their } a}$)
1st A1ft for a gradient of awrt 0.62 or 0.63 (allow 2sf ft on their values)
2nd M1 for a correct method to find the intercept (ft their gradient)
2nd A1 for a correct equation in *t* and *s* with *a* = awrt 13.1 and *b* = awrt 0.626
[No fractions]

(h) M1 for attempt to use mean + 2sd to establish the upper range of hours of sunshine (ft their mean and their sd)
A1ft for concluding that 5 is **outside** the range and estimate is **unreliable**
(If 'their mean' + 2 × 'their sd' > 5, allow A1ft for inside range, so reliable).

Question	Scheme	Marks
6. (a)	For sight of $0.6^2 \times 0.4$ (o.e.)	B1cso (1)
(b)(i)	P(X = 1) = **0.4**	B1
(ii)	P(X = 4) = 1 – "0.4" – 0.24 – 0.144 or $0.6^3 \times 0.4 + 0.6^4$ or 0.6^3 = **0.216**	M1 A1 (3)
(c)	$[\mathrm{E}(X) =] 1\times0.4 + 2\times0.24 + 3\times0.144 + 4\times0.216$, = 2.176 awrt **2.18**	M1, A1 (2)
(d)	$[\mathrm{E}(X^2) =] 1^2\times0.4 + 2^2\times0.24 + 3^2\times0.144 + 4^2\times0.216$ [= 6.112] Var(X) = "6.112" – 2.176"^{2} = 1.377024 awrt **1.38**	M1 M1 A1 (3)
(e)	stop after 1 head so 1 is the max value and can get no heads for 4 tails P(H = **0**) = **0.1296** and P(H = **1**) = **0.8704**	B1 B1 (2)
(f)(i)	$[\mathrm{P}(\{X = 3\} \cap \{H = 0\}) =]$ = **0**	B1
(ii)	$[\mathrm{P}(\{X = 4\} \cap \{H = 0\}) =]$ P(H = 0) = 0.6^4 = **0.1296** or $\frac{81}{625}$	B1ft (2)
(g)	[s] 2 3 4 5 [P(S = s)] 0.4 0.24 0.2736 0.0864	B1ft B1 B1ft B1 (4)
		(17 marks)

	Notes
(a)	B1 must come from $0.6^2 \times 0.4$ 0.6 × 0.24 on its own is B0
(b)(i)	B1 for 0.4 which may be seen in table.
(b)(ii)	M1 for a correct method for finding P(X = 4) (ft their P(X =1)) A1 for 0.216 or exact equivalent (e.g. $\frac{27}{125}$) (Correct answer only 2/2) (May be seen in table)
NOTE:	In (c) and (d) division by k at any stage scores M0 for E(X) and E(X^2)
(c)	M1 for an attempt at a correct expression, at least 3 correct products seen (allow ft) A1 for awrt 2.18
(d)	1st M1 for an attempt at a correct expression (or correct ft), at least 3 correct products seen for E(X^2) (ignore labels) 2nd M1 for a correct expression (ft their E(X) and their E(X^2) provided $\neq 2.176^2$) A1 for awrt 1.38
(e)	1st B1 for a clear explanation why max number of heads is 1 and when H = 0 2nd B1 for P(H = 0) = 0.1296 and P(H = 1) = 0.8704 or 0 1 0.1296 0.8704
(f)(ii)	B1ft for 0.1296 (o.e.) or their P(H = 0)
(g)	1st B1ft for P(S = 2) = P(X = 1) 2nd B1 for P(S = 3) = 0.24 3rd B1ft for P(S = 4) = 0.144 + (f)(ii) 4th B1 for P(S = 5) = 0.0864 [$0.6^3 \times 0.4$] with $\sum p = 1$ **and** with no other s and P(S = s) $\neq 0$ stated (e.g. P(S = 1) = p, $p \neq 0$ score 4th B0)

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