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Mark Scheme (Results)

October 2016

Pearson Edexcel International A Level Mathematics

Statistics 1 (WST01)

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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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON 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)
   - d… or dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - $*$ The answer is printed on the paper or ag- answer given
   - $\lfloor$ or d… 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. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

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

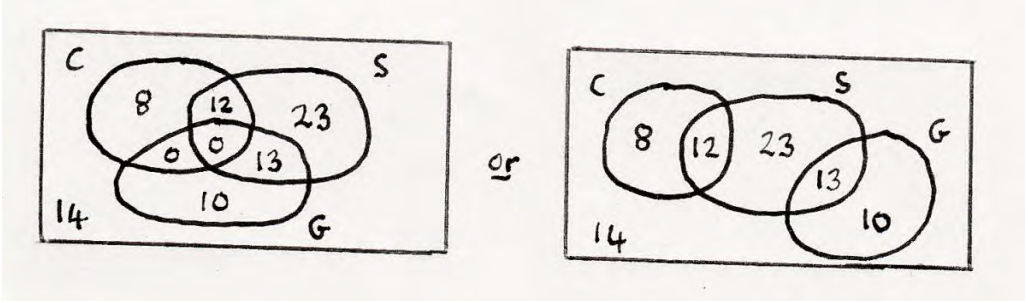
IAL Statistics 1 (WST01) – October 2016

Question Number	Scheme	Marks
1. (a)	[P($X > \mu - a$)] = **0.65**	B1 (1)
(b)	[P($\mu - a < X < \mu + a$)] = $1 - 2 \times 0.35$ or "0.65" – 0.35 or 0.15 + 0.15 = **0.3**	M1 A1 (2)
(c)	[P($X < \mu + a \mid X > \mu - a$)] = $\frac{\text{"(b)"}}{\text{"(a)"}} = \frac{0.3}{0.65}$ = $\frac{6}{13}$ (Allow awrt 0.462)	M1 A1 (2) **[Total 5]**
	Notes	
(a)	B1 for 0.65 NB you may see P($Z < 0.35$) = 0.6368 which is of course B0	
(b)	M1 for a correct numerical expression, ft their answer to part (a) [M0 for a probability < 0] A1 for 0.3 (Answer only scores both marks)	
(c)	M1 for a correct ratio of probabilities or follow through their answers provided (b) < (a) A1 for $\frac{6}{13}$ or an exact equivalent and allow awrt 0.462	

Question Number	Scheme	Marks
2. (a)	$2a + 2b + 0.2 = 1$ (o.e.)	B1 (1)
(b)	[E(X) =] $-2b - a + a + 2b + 3\times 0.2$ = **0.6**	M1 A1 (2)
(c)(i)	$\left[\mathrm{E}(X^2) = 3.5 \Rightarrow\right]$ $3.5 = (-2)^2 \times b + (-1)^2 \times a + a + 2^2 \times b + 3^2 \times \frac{1}{5}$ or $3.5 = 8b + 2a + 1.8$ or $8b + 2a = 1.7$ (o.e.)	M1
(ii)	Solving: $2a + 2b = 0.8$ and $2a + 8b = 1.7$ gives $6b = 0.9$ So ***a* = 0.25** and ***b* = 0.15**	M1 A1A1 (4)
(d)	[Var(X) =] $3.5 - "0.6"^2$ = 3.5 – 0.36 = **3.14**	M1 A1 (2)
(e)	P($5 - 3X > 0$) = P($5 > 3X$) = P($X < 1.66\ldots$) i.e. P($X = 1$ or -1 or -2) = **0.65**	M1 A1 A1ft (3)
(f)(i)	[E(Y) = 5 – 3E(X) = 5 – 1.8] = **3.2** (Allow any exact equivalent e.g. $\frac{16}{5}$)	B1
(ii)	[Var(Y) =] $(-3)^2 \mathrm{Var}(X)$ = $\left[9\times 3.14\right]$ = **28.26** or **28.3** or $\frac{1413}{50}$	M1 A1 (3) **[Total 15]**

	Notes
(a)	B1 for a correct equation based upon sum of probs. = 1
(b)	M1 for an attempt at E(X) i.e. an expression with at least 4 correct terms A1 for 0.6 or any exact equivalent. Allow 2/2 for 0.6 only or 0.6 following no incorrect working
(c)	1st M1 for an attempt to form a second linear equ'n in a and b using E(X^2), $\geqslant 3$ correct terms 2nd M1 for an attempt to solve their linear equ'ns…reducing to an equation in one variable. 1st A1 for either a or b correct 2nd A1 for both correct
(d)	M1 for a correct expression for Var(X) ft their 0.6 A1 for 3.14 or any exact equivalent e.g. $\frac{157}{50}$
(e)	M1 for attempt to solve the inequality leading to $X < 1.66\ldots$ Allow $5 > 3X$ leading to $X < 0.6$ A1 for identifying the 3 correct values of X required A1ft for 0.65 or ft their $2a + b$ ($a \neq b$)
(f)(ii)	M1 for seeing $(-3)^2 \mathrm{Var}(X)$ or better [ft their value of Var(X)] A1 for 28.26 or 28.3
ALT(e,f)	Distribution of Y (1st M1 in (e) for at least 3 correct y values) (1st A1 for 11, 8 and 2 with correct ft probs)
(f)(ii)	M1 for correct expression for E(Y^2) [= 38.5] and for Var(Y) = "38.5" – 3.2^2

y	11	8	2	– 1	– 4
P($Y = y$)	0.15	0.25	0.25	0.15	0.2

Question Number	Scheme	Marks
3. (a)		B1 B1 B1 B1 (4)
(b)(i)	$P(S) = \left[\frac{12+23+13}{80}\right] = \frac{48}{80}$ or $\frac{3}{5}$ or 0.6	B1ft (1)
(ii)	$P(S \mid C) = \frac{P(S \cap C)}{P(C)} = \frac{\frac{12}{80}}{\frac{20}{80}}$ $= \frac{12}{20}$ or 0.6	M1 A1cso (2)
(iii)	$P(S) = P(S\|C)$ or $P(C) = 0.25$, $P(C \cap S) = 0.15$ and $P(C) \times P(S) = 0.6 \times 0.25$ so S and C are independent	B1ft dB1ft (2)
(c)	Need $P(S \mid G) = \frac{13}{23}$ $P(S \mid C) = 0.6 > 0.565$ so assistant selling coats has the better performance	M1A1 A1 (3) **[Total 12]**

Notes

(a) 1st B1 for 3 labelled circles with 12, 13 & $n(C \cap G) = 0$ marked or implied (e.g.RH diagram)
2nd B1 for 8 and 10 correctly placed
3rd B1 for 23 correctly placed
4th B1 for box and 14

May use probabilities not integers
A blank space does not imply a zero

(b)(i) B1ft for 0.6 or any exact equivalent (single fraction) or ft their values (ft blank as 0)

(ii) M1 for a correct conditional prob. Correct expression and one correct ft prob. Num < Den
A1cso for 0.6 which must come from a denominator of 20

(iii) 1st B1ft for a full reason. If not $P(S) = P(S|C)$ then all values must be stated, labelled and correct or correct ft from diagram. Correct not'n required so $P(S \cup C) = 0.15$ is B0B0
2nd dB1ft dep. on a correct reason for correct conclusion for their values

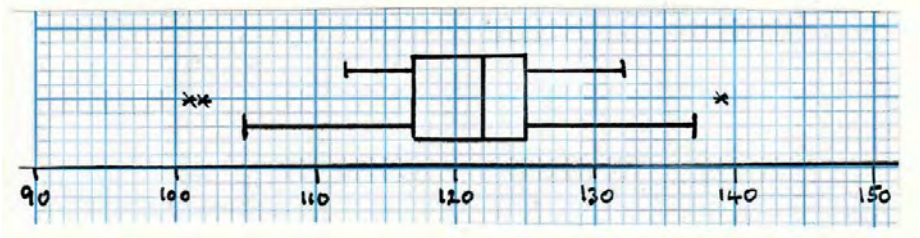
(c) M1 for attempt at $P(S \mid G)$ correct ratio of probabilities or numbers using their figs
1st A1 for $\frac{13}{23}$ (accept awrt 0.565) [Sight of $P(S \mid G) = \frac{13}{23}$ is M1A1]
2nd A1 for a correct conclusion that chooses "coats" based on a correct comparison
Allow incorrect $P(S|C)$ provided > 0.565 to score 2nd A1 and so all 3 marks
Condone poor use of notation eg $S|G$ with no P(..). Probabilities may be described in words.
Condone comparison of $\frac{13}{23}$ with 0.6 even if $\frac{13}{23}$ is not labelled as $P(S|G)$

Question Number	Scheme	Marks
4. (a)	$\sum f = 456$ or $\bar{f} = 57$ and $\sum f^2 = 26\,072$	M1, A1
	$\left[S_{ff}\right] = 26072 - \frac{456^2}{8}$ or $26072 - \frac{207936}{8}$ or $26072 - 25992 = 80$ (*)	A1 cso (3)
(b)	$\left[S_{hh}\right] = 610\,463 - \frac{2209^2}{8} = 502.875$ awrt **503**	M1, A1 (2)
(c)	$r = \frac{182}{\sqrt{80 \times "502.875"}} = 0.90739\ldots$ = awrt **0.907**	M1, A1 (2)
(d)	r is close to 1 or "strong" (positive) correlation (idea of "strong" required) … so **does** support the belief	B1ft (1)
(e)	$b = \frac{182}{80} = [2.275]$, $a = \frac{2209}{8} - b \times \frac{"456"}{8} = [276.125 - 129.675 = 146.45]$	M1, M1
	So $\boldsymbol{h = 146 + 2.28f}$ [Accept $h = 146 + 2.27f$]	A1A1 (4)
(f)	P($-3 < E < 3$) or 2P($0 < E < 3$)	M1
	= {2} $P\left(0 < Z < \frac{3}{4}\right)$	M1
	= 2(0.7734 – 0.5) = 0.5468 = awrt **0.547**	A1 (3)
		[Total 15]

	Notes
(a)	M1 for an attempt at Σf and Σf^2 where $400 < \Sigma f < 500$ and Σf^2 = awrt 30 000 1st A1 for $\Sigma f = 456$ and $\Sigma f^2 = 26\,072$ (456 may be implied by 207936 or 25992) 2nd A1cso for a correct expression leading to 80 with no incorrect working seen. Allow3/3 for $\Sigma f^2 - 57^2 \times 8$ or $\Sigma(f - 57)^2$ if all 8 terms seen or $5^2+4^2+1^2+2^2+3^2+5^2$ if leads to 80
(b)	M1 for a correct expression for S_{hh} A1 for awrt 503 (Answer only scores 2/2 and condone $\frac{4023}{8}$)
(c)	M1 for a correct expression using their value for S_{hh} but 182 and 80 must be correct. A1 for awrt 0.907 (Answer only M1A1 awrt 0.91 with no expression M1A0)
(d)	B1ft for a correct comment that uses their value of r as support e.g. "yes since strong correlation" For $\lvert r \rvert < 0.5$ allow comment that does not support.
(e)	1st M1 for a correct expression for b or awrt 2.28 (Allow 2.27 here as well) 2nd M1 for a correct expression for a ft their value for b and their 456 (using $b = r$ is M0) 1st A1 for either awrt 146 or awrt 2.28 correctly placed (so M1M0A1A0 is possible) 2nd A1 for a fully correct regression equation. Accept $h - 276 = 2.28(f - 57)$ [awrt 3 sf] (Allow 2.27 instead of 2.28 for the value of b, since $b = 2.275$)[Use of y and x is 2nd A0]
(f)	1st M1 for a correct probability statement (either of these two expressions) 2nd M1 for standardising with 3, 0 and 4 (allow ± 0.75 as answer). Ignore ×2 and 0 <… A1 for awrt 0.547 [NB M0M1A0 is common]

Question Number	Scheme	Marks
5. (a)	[P($A < 388$) = 0.001 $\Rightarrow$] $\dfrac{388-\mu}{\sigma} = \pm z$ (where $\lvert z\rvert > 2.25$)	M1
	So $388-\mu = -3.0902\sigma$ (o.e.)	A1
	[P($A > 410$) = 0.0197 $\Rightarrow$] $\dfrac{410-\mu}{\sigma} = \pm z$ (where $1 < \lvert z\rvert < 2.5$)	M1
	So $410-\mu = 2.06\sigma$ (o.e.)	A1
	So $22 = 5.1502\ \sigma$ (calc gives 5.1502323…)	M1
	$\underline{\boldsymbol{\sigma =}}$ 4.2716… (awrt **4.27**) and $\underline{\boldsymbol{\mu =}}$ 401.20… (awrt **401**)	A1, A1
		(7)
(b)	[Let X = profit in £]	
	x -100 -0.30 0.25	M1
	P($X = x$) 0.001 0.0197 $1 - (0.001 + 0.0197) = 0.9793$	M1
	$E(X) = -100\times0.001-0.30\times0.0197+0.25\times0.9793$	M1
	= 0.138915… (**£**) **0.14**	A1
	(allow any answer in the range 0.138…~0.141…)	
		(4)
		[Total 11]

	Notes
(a)	1st M1 for attempt to standardise with 388 and set equal to $\pm$ a z value where $\lvert z\rvert > 2.25$ 1st A1 for a fully correct equation with $z = -3.0902$ or better (calc gives 3.0902320…) 2nd M1 for attempt to standardise with 410 and set equal to $\pm$ a z value where $1 < \lvert z\rvert < 2.5$ 2nd A1 for a fully correct equation with z = awrt 2.06 (calc gives 2.059984…) 3rd M1 for solving their 2 linear equations in μ and σ (i.e. reduce to an equation in one var') Corect processes used but allow 1 sign or numerical slip. Must see the equation in one variable unless the correct answers are obtained in which case this can be implied. 3rd A1 for σ = awrt 4.27 (Allow 4.26 if 1st A0 for awrt -3.1) 4th A1 for μ = awrt 401 Use of σ^2 instead of σ in (a) will score 0/7
NB	**For 3rd and 4th A marks, apply a 1 mark penalty (A0) the first occasion that an answer in fraction form occurs. So, allow A1 for 2nd answer if both fractions give the correct awrt answers.**
(b)	1st M1 for the 3 correct values of x (i.e. -100, -0.30, $+0.25$) 2nd M1 for attempt at all 3 probabilities (correct expression for 0.9793) 3rd M1 dep on 3 values of X and 3 probs. For an expression for E(X) using their values A1 for an answer of 0.14 or in the range (0.138…~ 0.141…) Not awrt 0.14 Accept 0.13 if correct expression is seen beforehand

Question Number	Scheme	Marks
6. (a)	$Q_1 = 117$ $Q_2 = 122$ $Q_3 = 125$	B1B1B1 (3)
(b)	IQR = 125 – 117 = **8**	B1ft (1)
(c)	Upper limit: 125 + 1.5×8 = 125 + 12 = 137 Lower limit: 117 – 12 = 105 Outliers are: **101** **102** and **139**	M1A1 A1ft (3)
(d)		M1 A1ft B1 B1 (4)
(e)	[$\bar{x}$ =] **121** $[\sigma_x =]\sqrt{\frac{279709}{19} - \bar{x}^2} = \sqrt{14721.526... - 14641} = \sqrt{80.526...}$,= awrt **8.97**	B1 M1,A1 (3)
(f)	$\bar{x} + 2.7 \times \sigma_x =$ awrt 145 $\bar{x} - 2.7 \times \sigma_x =$ awrt 96.8 (allow 97)	M1A1 (2)
(g)	Probably not suitable…since: data is skewed or (f) says no outliers, (c) says 3 or (a) says median = 122, (e) says mean = 121	B1 (1) **[Total 17]**

	Notes
(a)	B1B1B1 for all 3 correct, B1B1B0 for any 2 correct and B1B0B0 for only one correct
(b)	B1ft for their greatest value from (a) – their smallest value from (a)
(c)	M1 for a correct expression for either limit, ft their values 1st A1 for both 137 and 105 identified 2nd A1ft for correctly identifying all the outliers using their limits. Must have scored M1 This 2nd A1ft can be awarded if all the outliers are seen on the box plot in (d)
(d)	M1 for a box and two whiskers (Must be on the grid, otherwise 0/4) A1ft for Q_1, Q_2 and Q_3 all plotted correctly, ft their values from (a) 1st B1 for lower whisker plotted at 105 or 112 and outliers at 101 and 102 2nd B1 for upper whisker plotted at 137 or 132 and an outlier at 139. (Whiskers must be compatible e.g. if lower whisker is at 105 upper must be at 137)
(e)	M1 for a correct expression including square root, ft their mean A1 for awrt 8.97 (Allow s = 9.2195… or awrt 9.22)
(f)	M1 for an attempt to calculate one limit, ft their mean and s.d. A1 for both limits correct allow awrt 145 and awrt 96.8 or 97

(g)	B1 for stating, or implying, normal <u>not</u> suitable **and** giving at least one supporting reason. A calculation or description of <u>skewness</u> is not required but if present must be correct for their values or their box plot. "Not normal since data is not continuous" is B0

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