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Mark Scheme (Final)

October 2019

Pearson Edexcel International Advanced 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.
- 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.

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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
   - $\llcorner$ or d… The second mark is dependent on gaining the first mark

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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.

Special notes for marking Statistics exams (for AAs only)

- If a method leads to "probabilities" which are greater than 1 or less than 0 then M0 should be awarded unless the mark scheme specifies otherwise.
- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct then please send to review.
- For method marks, we generally allow or condone a slip or transcription error if these are seen in an expression. We do not, however, condone or allow these errors in accuracy marks.
- If a candidate gives multiple solutions we mark the last complete solution. If in doubt send to review.

Question Number	Scheme	Marks
1(a)	$\left[S_{xy} =\right]$ = **1818**	B1
		(1)
(b)	$b = \frac{"1818"}{1754}$ [=1.036 or $\frac{909}{877}$] **ALT**	M1
	$c = -"1.036..."\times\frac{5}{8}$ or $\bar{f} = 80\times\frac{5}{8}+3500$	M1
	$= -0.6478$ [or $\frac{4545}{7016}$] or $\bar{h} = 4500$ and $\bar{f} = 3550$	A1
	$y = 1.04x - "0.6478..."$ or eqn of form $h = \ldots + 1.04f$	A1ft
	$\frac{h-4500}{80} = "1.036"\times\frac{f-3500}{80} - 0.6479...$ or $4500 - "1.04"\times 3550 = (820.467..)$	dM1
	$h = 820 + 1.04f$	A1
		(6)
(c)	On average for every increase in area of 1 (m^2) the annual heating bill increases by approximately ($) 1.04	B1ft
	The cost of heating is ($) 820 even if there is no floor space (no building) or the "standing charge" / "base rate" etc is ($) 820	B1ft
		(2)
(d)	"820.46..." + "1.036..." × 4600	M1
	= ($) 5588.31… ans in range (**5560-5610)**	A1 **(2)**
		Total 11

	Notes
(b)	1st M1 for use of $\frac{S_{xy}}{S_{xx}}$ ft their S_{xy} (allow correct use of S_{fh} etc)
	2nd M1 for $c = -(\text{their } b)\times\frac{5}{8}$ or **ALT** for a correct expression for $\bar{f}$
	1st A1 awrt –0.648 or **ALT** for correct values for both $\bar{h}$ and $\bar{f}$
	2nd A1ft for equ'n in the form $y = c + bx$ with their c and b = awrt 1.04 (dep on 1st M1 only) or **ALT** for $h = \ldots +$ (awrt 1.04)f [ignore any intercept]
	3rd dM1 (dep on 2nd M1) for substituting $\frac{h-4500}{80}$ and $\frac{f-3500}{80}$ into their regression line of y on x or **ALT** for correct method for intercept in h, f equation – ft their 1.04
	3rd A1 for $h = \text{awrt } 820 + \text{awrt } 1.04f$ [Do **not** allow fractions for this final mark]
(c)	**Must see correct words used, not just letters *f* and *h***
(i)	B1ft for correct interpretation need: "increase of area by 1" and "increase in bill by "1.04"" Can be other words giving same idea but must see their 1.04 (can ignore units)
(ii)	B1ft for a suitable explanation e.g. "cost if area is zero" Must see "their 820" (which must be > 0) but can ignore units. Accept reasonable alternatives to "standing charge"
(d)	M1 for substituting 4600 into their regress' line of h on f (or use of x = 13.75 in y, x equation) A1 allow answers in range 5580 - 5610

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Question Number	Scheme		Marks
2(a)	$10\times7.8\div1.2$ / $10\times7.8\times\frac{5}{6}$ / $\frac{1}{6}\times10\times39$	$5\times3.6\div1.2$ / $5\times3.6\times\frac{5}{6}$ / $\frac{1}{6}\times5\times18$	M1
	(Time 45-55 freq =) **65**	(Time 55-60 freq =) **15**	A1
	$260-"65+180"=$ **15**	$260-"15+180"=$ **65**	B1ft
			(3)
(b)(i)	$\left[\text{Mean}=\frac{11\,087.5}{260}\right]$ $=42.644\ldots$	awrt **42.6**	B1
			(1)
(ii)	Standard deviation $=\sqrt{\frac{505718.75}{260}-\left(\frac{11087.5}{260}\right)^2}=11.249\ldots(s=11.27...)$	awrt **11.2**	M1 A1
			(2)
(c)	Median $=(30)+15\times\frac{130-20}{145}$ or $(45)-15\times\frac{(165-130)}{145}$		M1
	$=41.379\ldots$	awrt **41.4**	A1
			(2)
(d)	Positive (skew) since the median is less than the mean		B1
	or Positive (skew) since the histogram has a "tail" on the right oe		
	(Allow use of quartiles if Q_1 =[34.65…] and Q_3 =[49.61…] are correct to 2sf)		**(1)**
(e)	Number of people $=\frac{6}{15}\times145+20$ [= 78]		M1
	Probability being less than 36 seconds $=\frac{78}{260}$ $=0.3$ o.e.		A1
	$\left(\frac{"78"}{260}\right)\times\left(\frac{"77"}{259}\right)\times\left(\frac{"76"}{258}\right)$; $=\frac{209}{7955}$ or 0.02627…	awrt **0.0263**	M1;A1
			(4)
			Total 13

	Notes	
(a)	M1 for a correct expression for one frequency A1 for 65 or 15 B1 for 15 or 65 ft one of their incorrect frequency or their "180"	**Look in table in QP** If table and text disagree take table.
(b)(i)	B1 for awrt 42.6 [Beware use of units e.g. 42.6s which looks like 42.65] (Allow $\frac{4435}{104}$)	
(ii)	M1 ft their mean. Must have the square root. [Allow use of their Σft^2 >300 000 here] A1 for awrt 11.2 [but allow 11.25] (allow s = 11.3) [Answer only 2/2]	
NB	[Beware correct formula with mean = 42.64 gives 11.265 = 11.3 (3sf) but scores M1A0]	
(c)	M1 for correct use of linear interpolation to find the median ignore the end points (may be implied by correct answer). NB may work up or down and allow use of 130.5 A1 for awrt 41.4 (Use of 130.5 gives 41.43…) [Again beware of units 41.4s etc]	
(d)	B1 positive (skew) with either reason[No ft for –ve skew if Q_2 > mean]. Ignore use of mode and condone "positive correlation" If $\lvert Q_2-\bar{t}\rvert<1$ allow mean close to median so no skew or symmetric.	
(e)	1st M1 for a correct method for finding the number of people. [Correct expression or 78] 1st A1 for the correct probability of 0.3 or exact equivalent 2nd M1 for use of their probability without replacement (condone with replacement) Score this mark for p^3 where p = their 0.3 from any method e.g. use of normal etc 2nd A1 for awrt 0.0263	

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Question Number	Scheme	Marks
3(a)	$\mathrm{P}(X<40)=\mathrm{P}\left(Z<\frac{40-42}{5}\right)=\mathrm{P}(Z<-0.4)$	M1
	$=1-0.6554$	M1
	$=0.3446$ awrt **0.345**	A1
		(3)
(b)	P(Qualify) $=1-("0.3446")^3$ or $(1-"0.3446")+("0.3446")(1-"0.3446")+("0.3446")^2(1-"0.3446")$ [$q=0.9590\ldots$ full calc: 0.9590867…]	M1
	$\mathrm{P}(X>45)=\mathrm{P}\left(Z>\frac{45-42}{5}\right)=\mathrm{P}(Z>0.6)$	M1
	$=1-0.7257$ or 0.2743 allow 1 – awrt 0.726 or awrt 0.274	A1
	$\mathrm{P}(X>45 \text{ on 3rd throw} \mid \text{in final})=\frac{"0.3446"^2\times"0.2743"}{"0.959"}$	dM1
	$=\frac{"0.0326..."}{"0.9590..."}$ (calc: 0.033952…)	
	= awrt **0.034**	A1
		(5)
		Total 8

	Notes
(a)	1st M1 for standardising with 40, 42 and 5. Allow $\pm\frac{40-42}{5}$
	2nd M1 for $1-p$ (where $p>0.5$)
	A1 awrt 0.345 (NB Calc gives 0.3445783…)
(b)	1st M1 for identifying <u>all</u> the cases to qualify with correct ft probabilities
	2nd M1 for an attempt standardise with 45, 42 and 5 ie $\pm\frac{45-42}{5}$
SC B1	**Use $\mu=40$** Using $\mu=40$ to find P($X>45$) will give 0.1587 and can award B1 if we see this <u>used</u> in an expression of the form $("0.3446")^2\times0.1587$. Score on epen as 2nd M0 1st A1
	They may also be able to score 1st M1 and 3rd M1 as well
	1st A1 for 1 – awrt 0.726 or awrt 0.274 (sight of either of these scores 2nd M1 and 1st A1)
	May be part of an expression such as $("0.3446")^2\times0.2743$
	3rd dM1 **dep on 1st M1** for $\frac{("\text{their } 0.3446")^2\times"\text{their } 0.2743"}{\text{their } q}$
	providing the numerator < denominator and num and denom are both probs
	2nd A1 for awrt 0.034 (NB numerator is awrt 0.033 so <u>must</u> be awrt 0.034)

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Question Number	Scheme	Marks
	If any part, especially (a) or (b), is missing send to review	
4(a)	0.72	B1 **(1)**
(b)	*C* (is most likely to be the 100 metre junior champion)	B1 **(1)**
(c) (i)	$S_{xx} = 3445.26 - \frac{164.4^2}{8}\left[= 66.84 \text{ or } \frac{1671}{25}\right]$	M1
	$r = \frac{60.85}{\sqrt{"66.84" \times 67.52}}$	M1
	$= 0.90578\ldots$ awrt **0.906**	A1 **(3)**
(ii)	The faster boys are in the the 100 metres, the faster they are in the 200 metres	B1 **(1)**
		Total 6

	Notes
(c) (i)	1st M1 for a correct expression, allow the use of $n = 10$, ie $S_{xx} = 3445.26 - \frac{164.4^2}{10}\left[= 742.524\right]$ Condone one slip e.g. 3445.6 instead of 3445.26 etc 2nd M1 for an attempt at a correct formula for r using S_{yy} and S_{xy} and their S_{xx} Condone one slip e.g. 60.84 or 66.48 miscopied for 66.84 A1 for awrt 0.906 NB Use of $S_{xx} = 742.524$ gives $r = 0.272$ and can score M1M1A0 provided expressions are seen for S_{xx} and r
(ii)	**NB on epen this is an A1 mark but we are treating it as a B1 It does not depend on M1 in (c)(i)** B1 allow equivalent statements e.g. on average boys that are faster/slower in the 100 metres are also faster/slower in the 200 metres Comment must be: (1) a comparison of <u>time</u> e.g. faster, quicker, slower etc (not "higher") **and** (2) mention <u>100 metres</u> or <u>200 metres</u> (and imply the other)

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Question Number	Scheme	Marks
5(a)(i)	$\mathrm{P}(D)=\frac{200}{320}=\frac{5}{8}$ (or exact equivalent e.g. 0.625)	B1 **(1)**
(ii)	$\mathrm{P}(D\cap X')=\frac{1}{2}$ oe	B1 **(1)**
(iii)	$\mathrm{P}(D'\cup Z')=\frac{320-88}{320}$; $=\frac{29}{40}=0.725$ o.e.	M1; A1 **(2)**
(b)	$\mathrm{P}(Z\mid D)=\frac{\frac{88}{320}}{"\frac{200}{320}"}$; $=\frac{88}{200}$ or $\frac{11}{25}$ or 0.44 oe	M1; A1 **(2)**
(c)	X and Y or X and Z or Y and Z (Allow X, Y etc)	B1 **(1)**
(d)	$\mathrm{P}(D)\times\mathrm{P}(X)=0.625\times0.2$ or $"\frac{5}{8}"\times\frac{64}{320}=0.125=\mathrm{P}(D\cap X)$ or $\mathrm{P}(D\mid X)=\frac{40}{64}=0.625=\mathrm{P}(D)$ or $\mathrm{P}(X\mid D)=\frac{40}{200}=\frac{1}{5}=\mathrm{P}(X)=\frac{24+40}{320}$ So yes they are independent	M1 A1 **(2)**
(e)(i)	A house that does not have a driveway but has exactly two cars	B1 **(1)**
(ii)	A house that has a driveway (with) fewer than two cars (oe)	B1 B1 **(2)**
		Total 12

	Notes
	If any part(s) of this question are missing please send to review
(a)(iii)	M1 for identifying the correct 7 values: 24, 40, 35, 37, 32, 44 and 20 or sum of 232 A1 for $\frac{29}{40}$ or exact equivalent e.g. 0.725
(b)	M1 for a ratio of probabilities with numerator of $\frac{88}{320}$ and denominator of their (a)(i) A1 for 0.44 or exact equivalent
(c)	B1 for at least one correct pair and no incorrect ones. Do not allow e.g. $\mathrm{P}(Y\cap Z)[=0]$ etc
(d)	M1 for a correct test with all required probs (labels and values) stated or implied - ft P(D) A1 for a correct conclusion – allow "yes they are" but must be events not probabilities e.g. a conclusion that P(D) and P(X) are independent is A0
(e)(ii)	1st B1 for a house that has a driveway 2nd B1 for fewer than two cars (Allow 0 or 1 but must not include both no car and 1 car) e.g. "has a driveway with 1 car and has a driveway with no car" is B1B0 **but** "has a driveway with 1 car or has a driveway with no car" is B1B1

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Question Number	Scheme	Marks
6 (a)	$\frac{3.968-\mu}{\sigma}=-1.2816$ or $\frac{4.026-\mu}{\sigma}=1.0364$	M1A1A1
	$\mu-1.2816\sigma=3.968$ (Calc: $-1.28155156\ldots$)	
	$\mu+1.0364\sigma=4.026$ (Calc: $1.03643338\ldots$)	
	$2.318\sigma=0.058$	dM1
	$\sigma=0.0250\ldots$ $\mu=4.00....$ awrt **0.025 and 4**	A1
		(5)
(b)	Q_3 = awrt 30.3 (calc: 30.337…) or $Q_3 - Q_1$ = awrt 0.6 oe (calc: 0.6744...)	B1
	$30.3+1.5("30.3"-29.7)\left[=31.2\right]$ or $29.7-1.5("30.3"-29.7)\left[=28.8\right]$	M1
	$P(L>"31.2")=P\left(Z>\frac{"31.2"-30}{0.5}\right)$ or $P(L<"28.8")=P\left(Z<\frac{"28.8"-30}{0.5}\right)$	M1
	$=0.0082$	
	Probability it is an outlier = 2×0.0082	M1
	$=0.0164$ answer in range **(0.006~0.017)**	A1
		(5)
		Total 10

	Notes
(a)	1st M1 for standardising with μ and σ and forming an equation in μ and σ with $\lvert z\rvert>1$
	1st A1 for one correct equation in any form with z value as given or better
	2nd A1 for a 2nd correct equation in any form allow 2dp or better for the z value
	2nd dM1 (dep on 1st M1) for correct method to solve* their 2 linear, simultaneous equations. Can be implied by both correct answers. [*Must see correct substitution or correct addition/subtraction of all 3 terms]
	2nd A1 for both μ = awrt 4 and σ = awrt 0.025 [Check it follows from their working.] NB Could score M1A0A1M1A1 or M1A1A0M1A1 here
(b)	B1 awrt 30.3 or IQR = awrt 0.6 or awrt 0.67
	1st M1 correct method for finding 1 outlier limit – ft their Q_3 or their IQR
	2nd M1 standardising with their limit, 30 and 0.5 allow ± leading to a probability < 0.05 Can be implied by a correct probability statement e.g. P(L < 28.8) = 0.0082
	3rd M1 multiplying their probability by 2 (or adding their two probs both < 0.05)
	A1 (dependent on all 3 M marks) for an answer in the range 0.006 ~ 0.017
Calc	**Use of full calc values:** If they use a calculator the lower limit is 28.651…upper limit is 31.3489 and probability comes to $2\times0.00348835...$ = awrt 0.00698

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Question Number	Scheme	Marks
7(a)(i)	$2a+2b=0.5$ oe ; $5a+11b=1.55$ oe (any unsimplified form)	B1; B1
	e.g. $5a+11(0.25-a)=1.55$ [implies $6a=1.2$ oe]	M1
	$a=0.2$*	A1 cso
(ii)	$b=$ **0.05**	B1
		(5)
(b)	$\left[\mathrm{E}(X^2)=\right]1^2\times0.35+2^2\times0.2+3^2\times0.2+4^2\times0.15+5^2\times0.05+6^2\times0.05$ [=8.4]	M1
	Var(X) = "8.4" -2.5^2 =[2.15]	M1
	Var ($4X+3$) = 16 Var (X)	M1
	= **34.4**	A1
		(4)
(c)	Expected profit = 2.5×60 or $2.5\times80-2.5\times20$ oe	M1
	= **150** (cents) or \$1.50 per customer	A1
		(2)
(d)	Let W be the profit, in cents per customer	
	y: 1, 2, 3, 5, 6	
	w: 60, 120, 180, 220, 280	B1; B1
	P($Y=y$): $\frac{3}{40}$, $\frac{4}{40}$, $\frac{3}{40}$, $\frac{22}{40}$, $\frac{8}{40}$	
	$\left[\mathrm{E}(W)\right]=\frac{1}{40}\left(60\times3+120\times4+180\times3+220\times22+280\times8\right)$	M1
	= **207** cents per customer	A1
	[May work in dollars e.g. \$2.67 or \$2.27 scores B1B0M1A0 and \$2.07 4/4]	**(4)**
		Total 15

	Notes
	Mark (a)(i) and (a)(ii) together
(a)(i)	1st B1 for a correct equation using Σprob = 1
	2nd B1 for a correct equation using E(X) = 2.5
	M1 dep on at least B1 for eliminating a or b leading to a linear equation in a or b only
	A1cso for a = 0.2 correctly shown. Dependent on M1 scored and two correct equations seen.
(ii)	B1 for b = 0.05 (or exact equivalent) Independent of other marks in (a)(i). **Look by table**
(b)	1st M1 for an attempt at E(X^2) with at least 3 correct products. Allow ft of their value of b
	Allow expression even if labelled Var(X) but label of Var(X) loses 2nd M1 but can get 3rd M1
	2nd M1 for use of E(X^2) – [E(X)]^2 ft their value of E(X^2)
	3rd M1 for seeing 16 Var(X) [Allow this mark if clearly stated Var(X) = E(X^2) = 8.4]
	A1 for 34.4 or exact equivalent e.g. $\frac{172}{5}$
(c)	M1 for 2.5×60 or any other fully correct equivalent expression (allow 2.5×0.6)
	A1 for 150 or accept \$1.5 (working with dollars requires units)
(d)	1st B1 for 1st 3 values of W (can allow in an expression for E(W)) **Look by table** but must be in part (d)
	2nd B1 for last 2 values for W
	M1 for attempt at E(W) ft their W values but at least 3 correct ft products
	Dependent on at least one of the first two B1 marks
	A1 for 207
ALT	**Use of E(Y)** [= 4.45] with at least 3 correct products seen **and** E(W) = pE(Y) – q
	1st B1 for p = 60 and 2nd B1 for $q=\left(\frac{22}{40}+\frac{8}{40}\right)\times80$ (or 60)
	M1 for E(W) expression of the form above and dep on at least one B mark scored

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