Mark Scheme (Results)

October 2018

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.

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.

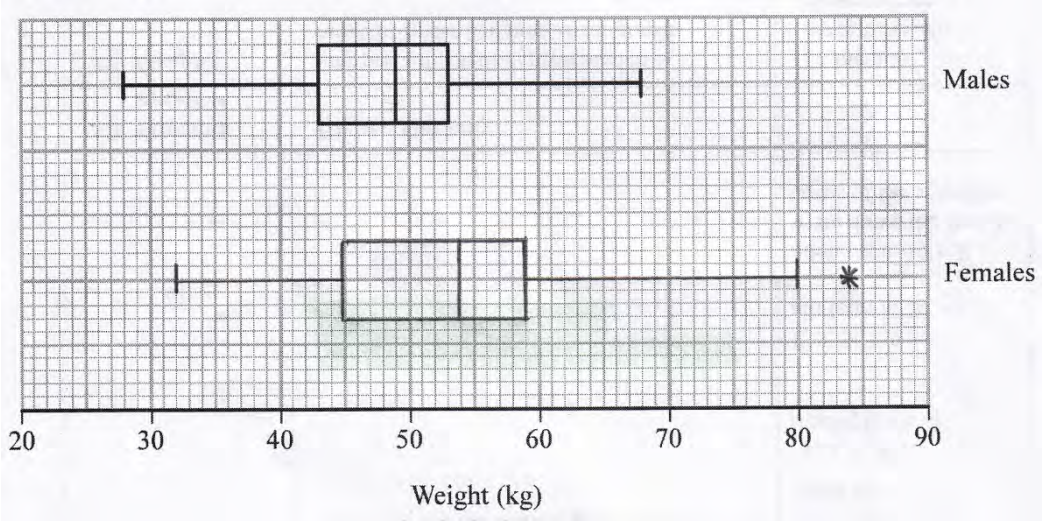
5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. 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.

Question Number	Scheme	Marks
1.(a)	$S_{tt} = 1828 - \frac{(136)^2}{12} = 286.6.....$ o.e. awrt **287**	M1A1 (2)
(b)	$r = \frac{S_{ht}}{\sqrt{S_{tt}S_{hh}}} = \frac{-236}{\sqrt{"286.6..."\times 297}}$ or $\frac{-236}{\sqrt{85140}}; = -0.8088...$ awrt **– 0.809**	M1A1 (2)
(c)	Temperature decreases as height increases.	B1ft (1)
(d)	$b = \frac{S_{ht}}{S_{hh}} = \frac{-236}{297} (= -0.7946...)$	M1
	$a = \bar{t} - b\bar{h} = 11.3... + 0.7946 \times 9.33... = 18.7497...$	M1
	$t = 18.7 - 0.795h$	A1 (3)
(e)	$t = 18.7 - 0.795 \times 5 = 14.7$	M1 A1 (2)
(f)	Unreliable as the data is from France not South Africa	B1 (1)
		Total 11

	Notes
	Correct numerical answers in (a), (b), (d) or (e) score all the marks for that part.
(a)	M1 Correct expression for S_{tt} A1 awrt 287 allow exact fractions e.g. $\frac{860}{3}$ or $286\frac{2}{3}$
(b)	M1 for attempt at correct formula, values must be substituted. Allow $\frac{-236}{\sqrt{287 \times 297}}$ A1 awrt – 0.809 (allow – 0.808 from a correct expression with 287 used)
(c)	B1ft for a comment in context. Must see "height" (or *h*) and "temperature" (or *t*) mentioned Allow "as the temperature increases the height above sea level decreases" (o.e.)
NB	If $\|r\| > 1$ score B0 in (c) Saying "sea level increases" (o.e.) is B0
(d)	M1 Correct expression for *b*. M1 Allow $11.3... - "\text{their } b \times 9.33..."$ [$a = \frac{16706}{891}$ scores M1 but A0] A1 *t* = (18.75 or awrt 18.7) – (awrt 0.795)*h* [No fractions and no *x*, *y*]
(e)	M1 substitute *h* = 5 or 500 into <u>their</u> regression line A1 answer in range [14.7 , 14.8] (condone coming from *y*, *x* equation)
(f)	B1 unreliable with a reason. [Use of 500 in (e) <u>and</u> stating "out of range" is B0] Must mention France or (S) Africa and at least imply the other

Question Number	Scheme	Marks
2.(a)	$Q_2 = 54$ $Q_1 = 45$ $Q_3 = 59$	B1 B1 B1 (3)
(b)	Upper limit = $59 + 1.5 \times 14 = 80$ Lower limit = $45 - 1.5 \times 14 = 24$ Outlier 84	M1 A1 A1ft (3)
(c)		B1 B1 B1 (3)
(d)	Any two from: The females are heavier than the males (on average). The males have lower median than females. The males have a smaller IQR than the females. The females have a greater range than males. [Comments just about skewness are B0]	B1 B1 (2)
	Notes	**Total 11**
(a)	1st B1 for $Q_2 = 54$ 2nd B1 for $Q_1 = 45$ 3rd B1 for $Q_3 = 59$	
(b)	M1 correct expression for either limit ft their values in (a) 1st A1 80 and 24 2nd A1ft all outliers identified using their limits (must be stated in (b))	
(c)	1st B1 Box with whiskers drawn and Q_2 and quartiles ft from(a), condone 2 whiskers on RHS 2nd B1 For only one lower whisker to 32 and no outliers 3rd B1 For upper whisker to 80 **or** 77 and an outlier at 84 **NB** If there are whiskers at both 77 and 80 it is 3rd B0	
(d)	1st B1 a correct comparison on location e.g. median or comment implying "on average" 2nd B1 a second correct comparison on spread e.g. range or IQR (greater spread is B0)	

Question Number	Scheme	Marks
3(a)	Width = 3 cm	B1
	1cm^2 represents 2 cars <u>or</u> 0.5cm^2 represents 1 car <u>or</u> their $h \times w = 6$ <u>or</u> area = 6	M1
	Height = $\frac{6}{3}$ = 2 cm	A1
		(3)
(b)	Median = $(2)+\frac{30-28}{15}\times 2$ or $(2)+\frac{30.5-28}{15}\times 2$ (o.e.)	M1
	= 2.266… (or 2.33…)	A1
		(2)
(c)	$\left[\bar{t}=\right]\ \frac{182}{60}=3.03...$	B1
	$\left[\sigma_t=\right]\ \sqrt{\frac{883}{60}-\bar{t}^{\,2}}\ =\sqrt{5.5155...}$	M1
	= 2.3485… (s = 2.3683…)	A1
		(3)
(d)	Mean > median	B1ft
	Positive skew	dB1
		(2)
(e)	[75 mins = 1.25 hours]	
	(> 75 mins) = $5+12+15+\frac{3}{4}\times 18=45.5$ <u>or</u> (< 75) = $10+\frac{1}{4}\times 18$ <u>or</u> $28-\frac{3}{4}\times 18$	M1
	P(T > 1.25) = $\frac{45.5}{60}$ <u>or</u> e.g. $1-\frac{14.5}{60}$	M1
	0.7583… awrt **<u>0.758</u>**	A1
		(3)
	Notes	**Total 13**
(a)	B1 3 only M1 may be implied by correct height A1 correct height of 2(cm) **and** correct width of 3 (cm)	
(b)	M1 for any correct equation leading to correct fraction as part of m = …or (m – [2]) = … Ignore incorrect end point and watch out for "working down" A1 awrt 2.27 allow exact fraction e.g. $\frac{34}{15}$ (allow awrt 2.33 [or $\frac{7}{3}$] if n +1 used)	
(c)	B1 awrt 3.03 (allow exact fraction e.g. $\frac{91}{30}$) M1 A correct expression A1 awrt 2.35 or 2.37	
(d)	1st B1 ft their mean and median (Allow "larger frequencies at the start of table") Do not allow comparison of quartiles unless correct values are seen (2sf comparisons) $Q_1 = 1.28$ or $\frac{23}{18}$ $[(n+1)=1.29]$ $Q_3 = 4.33$ or $\frac{13}{3}$ $[(n+1)=4.42]$ e.g. 2.1 > 0.99 or 2.1 > 1.0 2nd dB1 dependent on previous B1 being awarded.	
(e)	1st M1 for a correct expression for no. of cars longer than 75 mins or shorter than 75 mins 2nd M1 $\frac{k}{60}$ where $44 \leqslant k < 46$ A1 awrt 0.758 allow $\frac{91}{120}$ (o.e.)	
NB	Any use of the normal distribution is M0M0A0	

Question Number	Scheme	Marks
4.(a)	0.13	B1 (1)
(b)	$P(A)\times P(C)=P(A\cap C)$	
	$0.2\times(0.08+p)=0.05$ **or** $P(C)=\dfrac{0.05}{0.10+0.05+0.01+0.04}$ or $\dfrac{0.05}{0.2}$ or 0.25	M1
	$p=0.17$	A1
	P(no faults) $=1-(0.1+0.05+0.01+0.04+0.08+0.03+"0.17")$	M1
	or $1-$ ["P(C)" + 0.10 + 0.05 + 0.08]	
	q = **0.52**	A1
Ans only	They can get q without finding p so a correct answer to q scores 4/4	(4)
(c)	P(Fault B but not fault C | Has fault A) $=\dfrac{0.05}{0.2}$	M1
	= 0.25	A1 (2)
(d)	P(exactly 2 defects) = 0.12 or $\frac{3}{25}$	B1
	P(both have 2 defects) = 0.12^2	M1
	= **0.0144** or $\frac{9}{625}$	A1 (3)
		Total 10

	Notes
(a)	B1 0.13 only
(b)	1st M1 using $P(A)\times P(C)=P(A\cap C)$ allow one addition error in P(A) e.g. P(A) = 0.11
	1st A1 0.17 only
	2nd M1 $1-(0.10+0.05+0.01+0.04+0.08+0.03+"\text{their } 0.17")$ allow letter p for 0.17
	or $1-$ ["P(C)" + 0.10 + 0.05 + 0.08] but need a value for P(C) [M0A0M1A0 possible]
	2nd A1 0.52 only (correct answer of 0.52 with no incorrect working is 4/4)
(c)	M1 for attempt at $P(B\cap C'\mid A)$ allow for $\dfrac{0.06}{0.2}$ or $\dfrac{0.05}{0.2}$ allow ft of their P(A) used in part(b)
	A1 0.25
(d)	B1 sight of 0.12 or (0.05 + 0.03 + 0.04) only NB e.g. 0.12×2 is B1M0A0
	M1 $("0.12")^2$ where $0.1<"0.12"<0.2$
	May see attempt at $(0.05 + 0.03 + 0.04)^2$ multiplied out but must have $\geqslant$ 4 correct products
	A1 0.0144 (o.e.) (correct answer only scores 3/3)

Question Number	Scheme	Marks
5. (a)	$k = \frac{2}{35}$	B1
	x: 1 | 2 | 3 | 4 | 5 P($X = x$): $\frac{3}{35}$ | $\frac{5}{35}$ or $\frac{1}{7}$ | $\frac{7}{35}$ or $\frac{1}{5}$ | $\frac{9}{35}$ | $\frac{11}{35}$ P($X = x$): 0.08571.. | 0.14285.. | 0.2 | 0.25714.. | 0.31428..	M1 A1 (3)
(b)	$\frac{5}{35}+\frac{7}{35}=\frac{12}{35}$	M1 A1ft (2)
(c)	$\mathrm{E}(X)=1\times\frac{3}{35}+2\times\frac{5}{35}+3\times\frac{7}{35}+4\times\frac{9}{35}+5\times\frac{11}{35} \quad =\left[\frac{25}{7}\right]$	M1
	$\mathrm{E}(X^2)=1\times\frac{3}{35}+4\times\frac{5}{35}+9\times\frac{7}{35}+16\times\frac{9}{35}+25\times\frac{11}{35} \quad =\left[\frac{101}{7}\right]$	M1
	Var (X) = $\frac{101}{7}-\left(\frac{25}{7}\right)^2$; = $\frac{82}{49}$ (allow 1.67~1.674)	M1; A1
	Var($12 - 7X$) = $7^2\times\frac{82}{49}$; **= 82**	M1; A1 (6)
(d)	$4X \le \lvert Y\rvert$ when X = 1, 4 or 5, so probability = "$\frac{3}{35}$"+"$\frac{9}{35}$"+"$\frac{11}{35}$"	M1;A1ft
	= $\frac{23}{35}$	A1 (3)
	Notes	**Total 14**

(a) B1 may be implied by a correct probability
M1 need x values each with a prob and at least one correct prob.(Allow probs in terms of k)
A1 all values correct – accept decimals 3sf or better

(b) M1 "their P(X =2)" + "their P(X =3)"
A1ft ft providing <1 Allow answer in [0.3428, 0.343] or $6k$

(c)
1st M1 using $\sum xP(X=x)$ or $\frac{25}{7}$ or $\frac{125}{2}k$ or $\sum yP(Y=y)$ or -13 ($\geqslant$4 correct terms or ft)
2nd M1 using $\sum x^2P(X=x)$ or $\frac{101}{7}$ or $\frac{505}{2}k$ or $\sum y^2P(Y=y)$ ($\geqslant$4 correct terms or ft)
3rd M1 using Var(X) = E(X^2) –[E(X)]^2 or Var(Y) = E(Y^2) –[E(Y)]^2
1st A1 for a correct answer (allow 3sf) or for E(Y^2) = 251
4th M1 $49\times\text{Var}(X)$ or correct distribution for Y (ft probs from X)
2nd A1 for 82 only

(d) M1 for $X = 1,\ 4$ or 5 [or Y = 5, – 16, – 23] and at least one correct ft probability.
A1ft their "$\frac{3}{35}$";+ their "$\frac{9}{35}$"+ their "$\frac{11}{35}$" providing sum is <1 (allow in terms of k)
A1 cao (allow $\frac{23}{2}k$)

Dist of *Y*

y^2	25	4	81	256	529
y	5	– 2	– 9	– 16	– 23
P($X = x$)	$\frac{3}{35}$	$\frac{5}{35}$ or $\frac{1}{7}$	$\frac{7}{35}$ or $\frac{1}{5}$	$\frac{9}{35}$	$\frac{11}{35}$

F(x) = f(x) Get $k = \frac{2}{85}$ Can award: (a) 0/3 (b) M1A1ft (c) M4A0 (d) M1A1ftA0
All in *k* Can award: (a) B0M1A0 (b) 2/2 in (c) M4A0 (d) M1A1ftA1
Reverse *Y* May see $Y = 12 - 7(6 - X)$ used: in (c) can score M3 A0 probably zero in (d)

Question Number	Scheme	Marks
6. (a)	$P(L > 4.3) = P\left(Z > \frac{4.3-4.1}{0.125}\right)$	M1
	$= P(Z > 1.6)$ <u>or</u> $1 - P(Z < 1.6)$ <u>or</u> $1 - 0.9452$	M1
	$= 0.0548$	A1 (3)
(b)	$P(3.9 < L < 4.3) = P(Z < 1.6) - P(Z < -1.6)$ or $2(P(Z < 1.6) - 0.5)$ $= 0.9452 - 0.0548$ $= 2(0.9452 - 0.5)$ $= 0.8904$ $= 0.8904$	B1cso (1)
(c)	Number of unusable bolts $= (1 - 0.89) \times 500$ [= 55] Value of bolts = $"445" \times 9 + "55" \times 1$ profit = $"445" \times 9 + "55" \times 1 - 500 \times 5$ Profit from bolts $= 1560$ pence <u>Alternative</u> E(value of a bolt) = $0.89 \times 9 + 0.11 \times 1$ E(profit per bolt)= $0.89 \times 9 + 0.11 \times 1 - 5$ Profit = $"3.12" \times 500$ Profit from bolts $= 1560$ pence	M1oe M1oe M1oe A1 (4)
(d)	$\frac{4.198-\mu}{\sigma} = 1.96$ **or** $4.198 - \mu = 1.96\sigma$ **oe**	M1A1
	$\frac{4.065-\mu}{\sigma} = -0.7$ **or** $4.065 - \mu = -0.7\sigma$ **oe**	A1
	$0.133 = 2.66\sigma$	M1
	$\sigma = 0.05$ (or awrt 0.0500)	A1
	$\mu = 4.1$ (or awrt 4.10)	A1 (6)
(e)	The mean the same but the st. dev. decreased **or** $P(3.9 < L < 4.3)$ increased.	B1ft
	So the profit will increase	dB1ft (2)
	NB Use of + 0.7 in (c) $\rightarrow \mu = 3.99, \sigma = 0.106$, prob $\approx 0.80 \rightarrow$ profit down	**Total 16**

	Notes
(a)	1st M1 standardising. Allow use of 0.125^2 2nd M1 $1 - p$ $p > 0.8$ A1 awrt 0.0548
(b)	B1cso sight of 0.8904 or better (calc: 0.8904014212…) or a correct subtraction
(c)	1st M1 $(1 - "0.89") \times 500$ <u>or</u> $0.89 \times 9 + 0.11 \times 1$ 2nd M1 $"445" \times 9 + "55"$ <u>or</u> $0.89 \times 9 + 0.11 \times 1 - 5$ 3rd M1 method for the profit <u>or</u> their $"3.12" \times 500$ A1 for awrt £15.60 or 1560 pence(p) [need units] **SC** think 55 scrap **loses** 1p 1st M1 for sight of 55 B1 for answer of awrt 1450 p Score as: M1M0M0A1
(d)	1st M1 Forming either equation – must have z value but allow $\pm$ z where $\lvert z \rvert > 0.6$ 1st A1 correct equation $4.198 - \mu = 1.96\sigma$ - any form (or allow z = awrt 1.960) 2nd A1 correct equation $4.065 - \mu = -0.7\sigma$ - any form (or allow z = awrt -0.700) 2nd M1 eliminating μ or σ (method <u>seen</u> leading to equation in 1 variable) 3rd A1 0.05 (or awrt 0.0500) 4th A1 4.1 (or awrt 4.10 dep on 1st or 2nd A1) NB Candidate who assumes $\mu = 4.1$ can get M1 A0 A0M1A0A1
(e)	1st B1ft if $\mu = 4.1$ then ft σ ; if $\mu < 3.9$ (allow any σ) <u>otherwise</u> need to see $P(3.9 < L < 4.3)$ calc If they have $\mu = 4.1$ in part (d) then don't need to state "mean the same" in part (e) 2nd dB1ft therefore profit will increase (o.e.) [$\sigma < 0$ is B0B0]

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