Mark Scheme (Results)

October 2017

Pearson Edexcel International A Level
in Statistics S2 (WST02/01)

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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
- $\lfloor$ 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 Number	Scheme	Marks
1(a)	$\frac{200-\mu}{0.2} = -1.6449$	M1 A1
	$\mu = 200.3$ awrt **<u>200.3</u>**	A1
		(3)
(b)	$X \sim B(8, 0.05)$	B1
	$P(X \geq 3) = 1 - P(X \leq 2)$	M1
	$= 1 - 0.9942$	
	$= 0.0058$ awrt **<u>0.0058</u>**	A1
		(3)
(c)	$Y \sim Po(3)$	B1
	$P(Y > 5) = 1 - P(Y \leq 5)$	M1
	$= 1 - 0.9161$	
	$= 0.0839$ awrt **<u>0.0839</u>**	A1
		(3)
	Notes	**Total 9**
1(a)	M1 $\pm\frac{200-\mu}{\sqrt{0.04}} = \pm z$ value, $\lvert z \rvert > 1$	
	A1 for a correct equation with compatible signs and $z = 1.6449$ or better	
	A1 200.3 (condone awrt 200.3)	
	Note: M1A0A1 is possible	
(b)	B1 writing or using B(8, 0.05)	
	M1 writing or using $1 - P(X \leq 2)$	
	A1 awrt 0.0058	
(c)	B1 writing or using Po(3)	
	M1 writing or using $1 - P(Y \leq 5)$	
	A1 awrt 0.0839	

Question Number	Scheme	Marks
2(a)	$k\int_{2}^{10}(12s-20-s^2)\mathrm{d}s[=1]$	M1
	$k\left[6s^2-20s-\frac{s^3}{3}\right]_2^{10}[=1]$	A1
	$k\left(\frac{200}{3}+\frac{56}{3}\right)=1$	dM1
	$\frac{256}{3}k=1$	
	$k=\frac{3}{256}$	A1cso
		(4)
(b)	E(S) = 6	B1 (1)
(c)	$\mathrm{E}(S^2)=k\int_{2}^{10}(12s^3-20s^2-s^4)\mathrm{d}s$	M1
	$=\frac{3}{256}\left[3s^4-\frac{20s^3}{3}-\frac{s^5}{5}\right]_2^{10}$	A1ft
	= 39.2	
	Var (S) = $39.2-6^2=3.2$	M1
	s.d (S) = $\sqrt{3.2}$= 1.7888	dM1 A1
	∴ standard deviation = £1788.85 awrt **£1790**	A1ft
		(6)
(d)	$\frac{3}{256}\int_{7.1}^{10}(12s-20-s^2)\mathrm{d}s$	M1
	= 0.2989 = 0.3 (1 dp)	A1
		(2)
(e)	P($X \le 5$) = 0.8822	
	P($5 < X \le 6$) = P($X \le 6$) – P($X \le 5$)	M1
	= 0.9614 – 0.8822	
	= awrt 0.079	A1ft
	P($6 < X \le 12$) = 1 – P($X \le 6$) = 0.0386	M1
	Bonus earnt = 1000 × 0.0792 + 5000 × 0.0386	M1
	= £79.20 + £193.00	
	= £272.20 awrt **£270**	A1
		(5)
		Total 18

	Notes
2(a)	M1: attempting to integrate, at least one integral $s^n \to s^{n+1}$, ignore limits and does not need to be put equal to 1 A1: correct integration, ignore limits and does not need to be set equal to 1 M1: dependent on first M being awarded, **use** of both limits and setting equal to 1 Must see an intermediate line of working for this M1 mark to be scored A1 cso (condone use of *x* instead of *s*, condone missing d*s*, etc.)
(b)	Ignore (£)6000 if 6 is seen
(c)	M1 attempting to integrate s^2'their f(s)' $k\int_2^{10}(12s^3-20s^2-s^4)\mathrm{d}s$. $s^n \to s^{n+1}$ A1ft correct integration (or correct ft integration of s^2'their f(s)') M1 using $E(S^2) - [E(S)]^2$ M1 dependent upon previous M1 for square rooting Var(S) (Var(S) must be > 0) A1 awrt 1.79 (allow exact equivalent) A1ft awrt 1790 (dependent on all method marks scored for 1000 × their s.d.)
(d)	M1 correct expression and attempt to integrate with correct limits (ft their f(s)) $\frac{3}{256}\int_{7.1}^{10}(12s-20-s^2)\mathrm{d}s$ or $1-\frac{3}{256}\int_{2}^{7.1}(12s-20-s^2)\mathrm{d}s$ A1 awrt 0.3
(e)	M1 Writing or using $P(X \le 6) - P(X \le 5)$ or a correct expression for $P(X = 6)$ i.e. 12C6('their (d)')^6(1 –'their(d)')^6 where $X \sim B(12,$ "their ans to (d)") A1ft awrt 0.079 (allow f.t. their answer to (d)) M1 Writing or using $1 - P(X \le 6)$, where $X \sim B(12,$ "their ans to (d)") M1 1000 × "their 0.0792" + 5000 × "their 0.0386" A1 awrt £270 (2sf) **NB** if they use 0.2989 they can gain full marks. M1: $P(X = 6) = \binom{12}{6}(0.2989)^6(1-0.2989)^6$ A1: = 0.078254… awrt 0.078 M1: $P(6 < X \le 12) = 1 - P(X \le 6) = 0.0378589\ldots$ M1: Bonus earnt = 1000 × 0.078254… +5000 × 0.0378589… = £78.25 + £189.29 A1: = £267.54 (allow 267.55) awrt £270

Question Number	Scheme	Marks
3(a)	$P(B \geq 10) = 1 - P(B \leq 9)$ $= 1 - 0.7166$ $= 0.2834$ awrt **<u>0.283</u>**	M1 A1 (2)
(b)	Expected number of weeks = $0.2834 \times 50 = 14.2$ accept 14	M1 A1 (2)
(c)	$P(B \geq n) < 0.04$ where $B \sim Po(8)$ $P(B > 12) = 0.0638$ $P(B > 13) = 0.0342$ $\therefore 13$	 M1 A1 (2)
(d)	H_0: $\lambda = 8(80)$ H_1: $\lambda > 8(80)$ $Y \sim N(80, 80)$ $P(Y \geq 95) = P\left(Z > \frac{94.5 - 80}{\sqrt{80}}\right)$ $= P(Z > 1.62)$ $= 0.0526$ Do not reject H_0 There is no evidence that reducing the price of a *Birdscope* has increased **demand**.	B1 M1M1 M1 dM1 A1 M1 A1cso (8)
	Notes	**Total 14**
3(a)	M1 For writing or using $1 - P(B \leq 9)$ A1 awrt 0.283	
(b)	M1 for their (a) × 50 A1 awrt 14 (isw if 15 follows from awrt 14.2)	
(c)	M1 for any of these three lines (oe) A1 13	
(d)	B1 both hypotheses. Allow λ or μ, 8 or 80 M1Using Normal with mean 80 M1 Using Normal with mean = variance. Does not need to be 80. May be seen in the standardisation calculation. M1 $\pm\left(\frac{(95 \text{ or } 95.5 \text{ or } 94.5) - \textit{their mean}}{\textit{their sd}}\right)$ M1 dep on previous M1 being awarded. Using a continuity correction 95 ± 0.5 A1 correct standardisation and tail. Award for $Z > \frac{94.5 - 80}{\sqrt{80}}$ or Z > awrt 1.62 or a correct probability M1 A correct statement – do not allow contradictory non contextual statements. Follow through their Probability/CR and H_1. If no H_1 given then M0 A1 cso (all previous marks awarded) and a correct statement containing the word **demand** (oe).	

Question Number	Scheme	Marks
4(a)	$\frac{\alpha-6}{\alpha}=0.6$	M1
	$\alpha=15$	A1
		(2)
(b)	$P(4<X<10)=\frac{10-4}{15}$, $=\frac{2}{5}$ oe	M1, A1
		(2)
(c)	Mean = 10	B1
	Standard deviation = $\frac{10\sqrt{3}}{3}$ or awrt 5.77 or $\frac{20}{\sqrt{12}}$	B1
		(2)
(d)	$P(\lvert Y-4\rvert<2)$ = P $(2<Y<6)$	M1
	$=\frac{1}{5}$	A1
		(2)
(e) (i)	[P(X in middle 4cm) × P(Y in middle 4cm) =] $\frac{4}{15}\times\frac{4}{20}$	M1
	$=\frac{4}{75}$	A1
(ii)	[P(X in middle 5cm) × P(Y in middle 10 cm) =] $\frac{5}{15}\times\frac{10}{20}=\frac{1}{6}$	M1 A1
	[P(within 5 cm of the sides of the screen) =] $1-\frac{1}{6}=\frac{5}{6}$	dM1A1
		(6)
	Notes	**Total 14**
(a)	M1 $\frac{\alpha-6}{\alpha}=0.6$ (oe) or $\frac{6}{\alpha}=0.4$ (oe)	
(b)	M1 $\frac{10-4}{\text{their (a)}}$	
(d)	M1 Writing or using P $(2<Y<6)$	
(e)(i)	M1 $\frac{4}{\text{their(a)}}\times\frac{4}{20}$	
	A1 $\frac{4}{75}$ or awrt 0.0533	
(ii)	M1 $\frac{5}{\text{their(a)}}\times\frac{10}{20}$	
	A1 $\frac{1}{6}$ or awrt 0.167	
	dM1 dep on previous M1 for 1 – "their 0.167"	
	A1 $\frac{5}{6}$ or awrt 0.833	
	SC M0A0M1A0 for $(20\times\alpha)-50$ or $\frac{(20\times\alpha)-n}{(20\times\alpha)}$ where $0<n<300$ $n\neq 50$	

Question Number	Scheme	Marks
5(a)	F(6) = 1	
	$4k(12-7)=1$	M1
	$k=\frac{1}{20}$	A1
	$\alpha^2-2\alpha-3=4(2\alpha-7)$	M1
	$\alpha^2-10\alpha+25=0$	
	$(\alpha-5)^2=0$	
	$\alpha=5$	A1cao
	P(4.5 < X ≤ < 5.5) = F(5.5) – F(4.5)	M1
	$=4\times\frac{1}{20}\times(11-7)-\frac{1}{20}\times(4.5^2-9-3)$	dM1
	$=\frac{31}{80}$ or 0.3875 or awrt 0.388	A1
		(7)
(b)	$f(y)=\begin{cases}\frac{1}{20}(2y-2) & 3\le y\le 5\\ \frac{2}{5} & 5<y\le 6\\ 0 & \text{otherwise}\end{cases}$	M1 A1ft A1
		(3)
	Notes	**Total 10**
(a)	M1 Using F(6) =1 to get a linear equation in k i.e. $4k(12-7)=1$ A1 $\frac{1}{20}$ or 0.05 M1 Using F(α) ie $\alpha^2-2\alpha-3=4(2\alpha-7)$ A1 cao 5 M1 writing or using F(5.5) – F(4.5) M1 dep on previous M1 for subst 4.5 and 5.5 into the appropriate lines (allow ft for their value of α which may mean both values are substituted into the same line) A1 $\frac{31}{80}$ or awrt 0.388 Correct answer only scores 5 out of 7 Correct answer without finding α can score 5 out 7	
(b)	condone use of < in place of ≤ or vice versa throughout M1 attempt to differentiate $x^n\to x^{n-1}$ A1ft either 1st or 2nd line correct (ft their value of k and α) allow use of k and α A1 fully correct including 0 otherwise	

Question Number	Scheme	Marks
6	$X \sim \mathrm{N}\left(\frac{1}{6}n, \frac{5}{36}n\right)$	M1A1
	$\mathrm{P}(X < 50) = \mathrm{P}\left(Z < \frac{49.5 - \frac{1}{6}n}{\sqrt{\frac{5}{36}n}}\right)$	M1 dM1
	$\frac{49.5 - \frac{1}{6}n}{\sqrt{\frac{5}{36}n}} = -2.4$	M1 A1
	$49.5 - \frac{1}{6}n = -2.4\frac{\sqrt{5n}}{6}$	
	$n - 2.4\sqrt{5}\sqrt{n} - 297 = 0$	M1 A1
	$\sqrt{n} = \frac{2.4\sqrt{5} \pm \sqrt{(2.4\sqrt{5})^2 + 4 \times 297}}{2}$ $= 9\sqrt{5}$ or awrt 20.1	M1
	$n = 405$ only	A1cao
	Notes	**Total 10**
	M1 Using Normal with mean $\frac{1}{6}n$ A1 Using Normal with mean and Var correct M1 $\pm\left(\frac{(48.5 \text{ or } 49 \text{ or } 49.5 \text{ or } 50 \text{ or } 50.5) - \textit{their mean}}{\textit{their sd}}\right)$ M1 dep on previous M1 being awarded for using a continuity correction 49 ± 0.5 or 50 ± 0.5 M1 setting $\frac{(48.5 \text{ or } 49 \text{ or } 49.5 \text{ or } 50 \text{ or } 50.5) - \textit{their mean}}{\textit{their sd}} = z \textit{ value } \lvert z \rvert > 2$ A1 A correct equation with compatible signs with z value awrt 2.4 M1 rearranging to get a 3TQ in $\sqrt{n}$ or n A1 for a correct 3TQ equation in $\sqrt{n}$ or n e.g. $n - 2.4\sqrt{5}\sqrt{n} - 297 = 0$ M1 Solving (allow one slip in an expression) their 3TQ leading to $\sqrt{n}$ = or n = e.g. $\sqrt{n} = \frac{2.4\sqrt{5} \pm \sqrt{(2.4\sqrt{5})^2 + 4 \times 297}}{2}$ or $9\sqrt{5}$ or awrt 20.1 A1 cao with all previous marks scored.	

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