Mark Scheme (Results)

January 2014

Pearson Edexcel International Advanced Level

Statistics 2 (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 GCE 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 $\sqrt{}$ 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)	Let X = the number of leaf cuttings successfully taking root	
	$X \sim B(10, 0.05)$	B1
(i)	$P(X = 1) = P(X \leqslant 1) - P(X = 0)$ or ${}^{10}C_1 \times 0.05 \times 0.95^9$	M1
	$= 0.9139 - 0.5987$	
	$= 0.3152$ awrt 0.315	A1
(ii)	$P(X > 2) = 1 - P(X \leqslant 2)$	M1
	$= 1 - 0.9885$	
	$= 0.0115$ awrt 0.0115	A1
		(5)
1(b)	$Y \sim Po(8)$	B1
	$P(Y \geqslant 10) = 1 - P(Y \leqslant 9)$	M1
	$= 1 - 0.7166$	
	$= 0.2834$ awrt 0.283	A1
		(3)
		Total (8)

Notes

(a)	B1 use of B(10,0.05). May appear in (i) or (ii) or may be implied	
(i)	M1 writing or using $P(X \leqslant 1) - P(X = 0)$ or ${}^{n}C_1 \times p \times (1-p)^{n-1}$ $(0 < p < 1)$	
(ii)	M1 writing or using $1 - P(X \leqslant 2)$	
(b)	B1 writing or using Po(8) or writing or using N(8,7.6)	
	M1 writing or using $1 - P(Y \leqslant 9)$ or for M1 for $P\left(Z > \frac{9.5-8}{\sqrt{7.6}}\right)$	
	A1 for awrt 0.283 from poisson or an answer in the range (0.293,0.295) from normal	
	NB using binomial, $P(X \geqslant 10) = 0.280125...$scores B0M0A0	
	Answer only 0.28 or awrt 0.280 scores B0M0A0	
	Answer only awrt 0.283 scores B1M1A1	
	Answer only in the range (0.293,0.295) B1M1A1	

Question Number	Scheme	Marks
2(a)	**<u>List</u>** of all the **<u>customers</u>** (who eat in the restaurant)	B1 (1)
(b)	**<u>Customer(s)</u>** (who ate in the restaurant)	B1 (1)
(c)	Advantage: more/total accuracy, unbiased	B1
	Disadvantage: time consuming to obtain data and analyse it, expensive, difficult to ensure entire population is included	B1 (2)
(d)	Let X = the number of customers who would like more choice on the menu.	
	$H_0: p = 0.3$ $H_1: p > 0.3$	B1
	$X \sim B(50,0.3)$	M1
	$P(X \geqslant 20) = 1 - P(X \leqslant 19)$ or CR $P(X \leqslant 20) = 0.9522$	M1
	$= 1 - 0.9152$ $P(X \geqslant 21) = 0.0478$	
	$= 0.0848$ $X \geqslant 21$	A1
	Do not reject H_0/ not significant/20 is not in critical region	M1
	The percentage of <u>customers</u> who would like more <u>choice</u> on the menu is not more than Bill believes. or There is no evidence to reject <u>Bill's</u> <u>belief</u>.	A1cso (6)
		Total (10)
Notes		
(a)	B1 Need the idea of list/register/database and 'customer(s)' Do not allow customer's opinions. 'All' may be implied. Do not allow a partial list e.g. 'A list of 50 customers'	
(b)	B1 customer(s)	
(c)	If not labelled, assume the response refers to a census. 1st B1 is for the advantage and 2nd B1 is for the disadvantage.	
(d)	B1 need both hypotheses with p M1 using B(50,0.3) M1 for $1 - P(X \leqslant 19)$ or $P(X \leqslant 20) = 0.9522$ or $P(X \geqslant 21) = 0.0478$ leading to a **critical region** $X > k$ or $X \geq k$ A1 awrt 0.0848 or critical region $X \geqslant 21$ or $X > 20$ M1 a correct conclusion for their probability. May be implied by a correct contextual conclusion. A1 a correct contextual conclusion for their hypotheses and a fully correct solution with no errors seen. Must mention 'customers' and 'choice' <u>or</u> 'Bill' and 'belief'. NB $P(X=20)$ can score B1M1M0A0M0A0 NB normal approximation gives 0.082(457…) and loses all A marks	

Question Number	Scheme	Marks
3(a)	$\frac{1}{6}a(a+1)=0.6$	M1
	$a^2+a-3.6=0$	
	$a=\frac{-1\pm\sqrt{1+4\times 3.6}}{2}$	M1
	$=1.462\ldots$ a = 1.46 only	A1
		(3)
3(b)	$\mathrm{f}(x)=\frac{\mathrm{d}}{\mathrm{d}x}\mathrm{F}(x)=\frac{1}{3}x+\frac{1}{6}$	M1A1
(i)	$\mathrm{E}(X)=\int_0^2 x\left(\frac{1}{3}x+\frac{1}{6}\right)\mathrm{d}x$	M1
	$=\left[\frac{x^3}{9}+\frac{x^2}{12}\right]_0^2$	A1
	$=\frac{11}{9}$ awrt 1 .22	A1
(ii)	$\mathrm{Var}(X)=\int_0^2 x^2\left(\frac{1}{3}x+\frac{1}{6}\right)\mathrm{d}x-\left(\frac{11}{9}\right)^2$	M1
	$=\left[\frac{x^4}{12}+\frac{x^3}{18}\right]_0^2-\left(\frac{11}{9}\right)^2$	A1ft
	$=\frac{23}{81}$ awrt 0.284	A1
		(8)
		Total (11)

Notes

(a)	M1 putting F(x) = 0.6 or 1 – 0.4 M1 attempting either completing the square or quadratic formula (one slip allowed) (condone + instead of $\pm$) Must set f(a) = 0.6 or f(a) = 0.4 to score this mark. May be implied by implied by awrt 1.46 or awrt -2.46 A1 for 1.46 only (must reject other root if stated) (condone awrt 1.46)
(b) (i)	1st M1 attempting to differentiate F(x) at least one $x^n \to x^{n-1}$ 2nd M1 for intention to use $\int_0^2 x\mathrm{f}(x)\,\mathrm{d}x$ using their f(x) which must be a changed function from F(x). No need for limits 2nd A1 correct integration (may be unsimplified)
(ii)	3rd M1 for intention to use $\int x^2\mathrm{f}(x)\,\mathrm{d}x-\mu^2$ using their f(x) which must be a changed function from F(x). No need for limits. This may be seen on separate lines. Must substitute their value of μ/E(X) 4th A1ft correct integration. Ft their E(X).

Question Number	Scheme	Marks
4(a)	(H_1:) $\lambda > 1.5$	B1 (1)
4(b)	$C \sim \text{Po}(6)$	B1
	$P(C > 10) = 1 - P(X \le 10)$	M1
	$= 1 - 0.9574$	
	$= 0.0426$ awrt 0.0426	A1
		(3)
4(c)	$P(X \le 10 \mid \mu = 7) = 0.9015$	M1
	$P(X \le 10 \mid \mu = 7.5) = 0.8622$	
	Parameter $\mu = 7$	A1
	$\lambda = \frac{7}{4}$, 1.75	A1
		(3)
		Total (7)

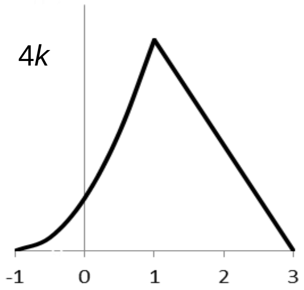
Notes

(a)	B1 Must use λ	
(b)	B1 writing or using Po(6) M1 writing or using $1 - P(X \le 10)$ A1 do not isw. e.g. If the response goes on to state the level of significance is 5%, withhold the A mark. NB $P(X \leqslant 9) = 0.9161$ $P(X \le 11) = 0.9799$ can imply B1	
(c)	M1 either $P(X \le 10 \mid \mu = 7)$ = 0.9015 or $P(X \le 10 \mid \mu = 7.5)$ = 0.8622 award for sight of 0.9015 (or 0.0985) <u>or</u> 0.8622 (or 0.1378) NB $\lambda = 7$ scores M1A1A0 allow awrt 1.76 from calculator to score M1A1A1	

Question Number	Scheme	Marks
5(a)	Let X = the number of break downs per month	
	$X \sim \text{Po}\left(\frac{15}{12}\right)$	B1
	$\text{P}(X = 3) = \frac{e^{-1.25}1.25^3}{3!}$	M1
	$= 0.0933$ awrt 0.0933	A1
		(3)
(b)	$\text{P}(X \geqslant 2) = 1 - \text{P}(X = 0) - \text{P}(X = 1)$	
	$= 1 - e^{-1.25}(1 + 1.25)$	M1
	$= 0.35536\ldots$	
	$= 0.355$ **AG	A1cso
		(2)
(c)	$(0.355)^4 = 0.0159$ awrt 0.016	M1A1
		(2)
(d)	Y ~ number of months the photocopier does break down at least twice.	
	$Y \sim \text{B}(12, 0.355)$	M1A1
	$\text{P}(Y \geq 2) = 1 - \text{P}(Y = 0) - \text{P}(Y = 1)$	dM1
	$= 1 - (1 - 0.355)^{12} - 12(1 - 0.355)^{11}(0.355)$	A1
	$= 0.961$	A1
		(5)
		Total (12)

Notes

(a)	B1 writing or using Po(1.25)	
	M1 $\frac{e^{-\lambda}\lambda^3}{3!}$	
(b)	**NB remember the answer is given (AG) so they must show their working**	
	M1 $1 - \text{P}(X = 0) - \text{P}(X = 1)$ or $1 - \text{P}(X \leqslant 1)$ **and** a correct expression using their λ	
	Condone 0.3554 or better	
(c)	M1 Their $[(\text{b})]^4$	
(d)	M1 for identifying Binomial	
	1st A1 B(12, their (b))	
	dM1 $1 - \text{P}(Y = 0) - \text{P}(Y = 1)$ or $1 - \text{P}(X \leqslant 1)$ dependent on 1st M1	
	2nd A1 for a correct expression	
	3rd A1 for awrt 0.961	

Question Number	Scheme	Marks
6(a)		B1 B1 (2)
(b)	$\int_{-1}^{1} k(x+1)^2\,dx + \int_{1}^{3} k(6-2x)\,dx = 1$ $\int_{-1}^{1} k(x^2+2x+1)\,dx + \int_{1}^{3} k(6-2x)\,dx = 1$ $k\left[\frac{x^3}{3}+x^2+x\right]_{-1}^{1} + k\left[6x-x^2\right]_{1}^{3} = 1$ $k\left[2\tfrac{1}{3}+\tfrac{1}{3}\right]+k\left[9-5\right]=1$ $6\tfrac{2}{3}k=1$ $k=\frac{3}{20}$ **AG	M1 M1A1 dM1 A1cso (5)
(c)	$\int_{-1}^{x} k(x^2+2x+1)\,dx = k\left[\frac{x^3}{3}+x^2+x\right]_{-1}^{x}$ or $\left[\frac{k}{3}(x+1)^3\right]_{-1}^{x}$ $= \frac{3}{20}\left(\frac{x^3}{3}+x^2+x+\frac{1}{3}\right)$ or $\frac{1}{20}(x+1)^3$ $\int_{1}^{x} k(6-2x)\,dx + \int_{-1}^{1} k(x^2+2x+1)\,dx = k\left[6x-x^2\right]_{1}^{x}+\frac{2}{5}$ $=\frac{3}{20}(6x-x^2-5)+\frac{2}{5}$ $=\frac{9}{10}x-\frac{3}{20}x^2-\frac{7}{20}$ $$\mathrm{F}(x)=\begin{cases} 0 & x<-1 \\ \frac{3}{20}\left(\frac{x^3}{3}+x^2+x+\frac{1}{3}\right) & -1\le x\le 1 \\ \left(\frac{9}{10}x-\frac{3}{20}x^2-\frac{7}{20}\right) & 1<x\le 3 \\ 1 & x>3 \end{cases}$$	M1 M1 B1 A1 A1 (5)

Question Number	Scheme	Marks
6. cont. (d)	$\frac{9}{10}x-\frac{3}{20}x^2-\frac{7}{20}=0.5$	M1
	$3x^2-18x+17=0$	
	$x=\frac{18\pm\sqrt{18^2-4\times3\times17}}{6}$	dM1
	x = 1.17 only	A1
		(3)
		Total (15)

Notes

(a)	B1 correct shape with correct curvature and straight line with negative gradient. Must start and end on the x-axis. B1 –1, 1, 3 and $4k$ (or 0.6) labelled in the correct place
(b)	M1 adding two areas and putting equal to 1 eg $\int_{-1}^{1}k(x+1)^2dx+4k=1$ M1 attempting to integrate (at least one $x^n\to x^{n+1}$) or finding area of triangle A1 correct integration $k\left(\frac{x^3}{3}+x^2+x\right)$ and $k(6x-x^2)$ <u>or</u> $k\left(\frac{x^3}{3}+x^2+x\right)$ and $4k$ <u>or</u> $k\left(\frac{(x+1)^3}{3}\right)$ and $k\left(\frac{(6-2x)^2}{-4}\right)$ M1 dependent on previous two M marks. For using correct limits A1 correct solution with no incorrect working seen
(c)	For both M marks, attempt to integrate at least one $x^n\to x^{n+1}$ M1 for attempt to integrate line 1 of f(x) with correct limits <u>or</u> with + c and substituting in –1 and setting = 0 M1 for attempt to integrate line 2 of f(x) with correct limits and adding $\frac{2}{5}$ oe or their F(1) <u>or</u> with + c and substituting in 3 and setting = 1 B1 top and bottom row correct 1st A1 for 2nd line of F(x) with correct range 2nd A1 for 3rd line of F(x) with correct range Do not penalise the use of $\leq$ instead of < and $\geq$ instead of >
(d)	M1 for setting their 2nd line or 3rd line of F(x) = 0.5 dM1 for solving a 3 term quadratic dependent on first M1 (must be using their 3rd line of F(x)) A1 for 1.17only (condone awrt 1.17) must reject other solution (4.825….)

Question Number	Scheme	Marks
7	$\dfrac{64.5-\mu}{\sigma}=0.75$	B1 M1 M1 A1
	$\dfrac{52.5-\mu}{\sigma}=-1.25$	A1
	$64.5-\mu=0.75\sigma$	dM1
	$52.5-\mu=-1.25\sigma$	
	$\sigma = 6$	A1
	$\mu = 60$	A1
	$np = 60$	M1
	$np(1 - p) = 36$	M1
	$1 - p = 0.6$	
	$p = 0.4$	A1
	$n = 150$	A1
		(12)
		Total (12)

Notes

	B1 ±0.75 and ±1.25 (or better) seen 1st M1 64 ± 0.5 or 52 ± 0.5 2nd M1 standardising either using 64, 65 or 64 ± 0.5 or $52, 53$ or 52 ± 0.5 with μ and σ <u>or</u> *np* and $\sqrt{np(1-p)}$ (need not be set equal to a z-value) 1st A1 for $\dfrac{64.5-\mu}{\sigma}=0.75$ (with compatible signs) 2nd A1 for $\dfrac{52.5-\mu}{\sigma}=-1.25$ (with compatible signs) 3rd M1 solving simultaneous equations dependent on 2nd M1. Must attempt to eliminate μ or σ <u>or</u> *np* or $\sqrt{np(1-p)}$ 3rd A1 σ = 6 4th A1 μ = 60 4th M1 using $\mu = np$ (may be awarded at any stage in the working) 5th M1 using $\sigma=\sqrt{np(1-p)}$ (may be awarded at any stage in the working)	

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