edexcel

Mark Scheme (Results)

Summer 2015

Pearson Edexcel GCE in Statistics 2 (6684/01)

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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.

PEARSON 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 $\surd$ 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.

Question Number	Scheme		Marks
1. (a)		**notes**	
	$P(N \geq 10) = 1 - P(N \leq 9)$	M1: using or writing $1 - P(N \leq 9)$ or $1 - P(N < 10)$	M1 A1
	= 0.4126	A1: awrt 0.413	
(b)	Y represents number of owls per 200 km^2 $\Rightarrow$ $Y \sim$ Po(1.8)	B1: using or writing Po(1.8)	B1
	$P(Y = 2) = \frac{e^{-1.8}1.8^2}{2!}$	M1 : for a single term of the form $\frac{e^{-\lambda}\lambda^2}{2!}$ with any value for λ or $P(X \leq 2) - P(X \leq 1)$	M1 A1
	= 0.2678	A1: awrt 0.268	
(c)	Normal approximation	M1: Using or writing, normal approximation with mean = 450	M1
	$\mu = 50 \times 9 = 450 \quad \sigma^2 = 450$	M1: Using or writing the mean = variance. Does not need to be 450. May be seen in the standardisation calculation.	M1
	$P(X \geq 470) \approx 1 - P\left(Z < \frac{469.5 - 450}{\sqrt{450}}\right)$	M1: $\pm\left(\frac{(470 \text{ or } 469.5 \text{ or } 470.5) - \textit{their mean}}{\textit{their sd}}\right)$ May be implied by a correct answer or z = awrt 0.92	M1
		M1: dep on previous method mark being awarded. Using a continuity correction 470 ± 0.5 May be implied by a correct answer or z = awrt 0.92	dM1 A1
		A1: correct standardisation no need to subtract from 1. Award for $\frac{469.5 - 450}{\sqrt{450}}$ or awrt 0.92 or a correct answer	
	= 0.1788	A1: awrt 0.179	A1 **(6)**

Question Number	Scheme		Marks
2(a)		**notes**	
	$X \sim B(30, 0.25)$	B1: using B(30, 0.25)	B1
	$P(X \leq 10) - P(X \leq 4) = 0.8943 - 0.0979$	M1: using $P(X \leq 10) - P(X \leq 4)$ or $P(X \geq 5) - P(X \geq 11)$ oe	M1 A1
	$= 0.7964$	A1: awrt 0.796	
	NB a correct answer gains full marks		

(b)	$H_0 : p = 0.25$ $H_1 : p < 0.25$	B1: Both hypotheses correct, labelled H_0 or NH or H_n and H_1or AH or H_a , must use p or $p(x)$ or π	B1
	B(15, 0.25)	M1: for using B(15, 0.25)	M1 A1
	$P(X \leq 1) = 0.0802$	A1: awrt 0.0802 or CR $X \leq 1$ (allow $P(X \geq 2) = 0.9198$)	
	NB: Allow M1 A1 for a correct CR with no incorrect working		
	Reject H_0 or Significant or 1 1ies in the critical region	M1: A correct statement – do not allow contradictory non contextual statements. Follow through their Probability/CR (for 1 or 2 tail test). If no H_1 given then M0. Ignore their comparison. For a probabillity < 0.5, statement must be correct compared to 0.1 for 1 tail test and 0.05 for 2 tailed test or if the probability > 0.5, statement must be correct compared to 0.9 for 1 tail test and 0.95 for 2 tailed test.	dM1 A1cso
	There is evidence that the radio **company's** claim is true. **Or** The new transmitter will reduce the proportion of houses unable to receive **radio**	A1: cso (all previous marks awarded) and a correct statement containing the word **company** if writing about the claim or **radio** if full context**.**	

Question Number	Scheme		Marks
		Notes	
3(a)	$\int_0^2 kx^2 \mathrm{d}x + \int_2^6 k\left(1-\frac{x}{6}\right)\mathrm{d}x = 1$	M1: for adding the two integrals, and attempting to integrate, at least one integral $x^n \to x^{n+1}$, ignore limits and does not need to be put equal to 1. Do **not** award if they add before integrating	M1 A1
	$k\left[\frac{x^3}{3}\right]_0^2 + k\left[x-\frac{x^2}{12}\right]_2^6 = 1$	A1: correct integration, ignore limits and does not need to be put equal to 1	
	$k\left[\frac{8}{3}\right] + k\left[3-\frac{5}{3}\right] = 1$	M1: dependent on first M being awarded, correct use of limits and putting equal to 1. This may be seen as F(2) $= \frac{8}{3}k$ and using F(6) = 1	dM1 A1cso
	$4k = 1$	A1: cso answer given so need $4k = 1$ leading to $k = \frac{1}{4}$	
	$k = \frac{1}{4}$ *		
NB Validation – if they substitute in *k* = ¼ you may award the 1st three marks as per scheme. For the Final A mark they must say " therefore *k* = ¼"			

(b)	2	B1: cao	B1

(c)	$\int_0^x kt^2 \mathrm{d}t = \frac{kx^3}{3}$	M1: attempting to find $\int_0^x kt^2 \mathrm{d}t$ $t^2 \to t^3$, ignore limits, may leave in terms of *k*	M1
	$\int k\left(1-\frac{t}{6}\right)\mathrm{d}t = k\left[t-\frac{t^2}{12}\right]+C$ $= kt - k\frac{t^2}{12} + C$ F(6) =1 $6k - 3k + C = 1 \ \ \therefore C = \frac{1}{4}$	M1: attempting to find $\int k(1-\frac{t}{6})\mathrm{d}t$ at least one integral $t^n \to t^{n+1}$ **and** either have + C $(C \neq 0)$ and use F(6) =1 **or** have limits 2 and *x* and + "their $\int_0^2 kt^2 \mathrm{d}t$ " and attempt to integrate $t^n \to t^{n+1}$ NB: may use any letter, need not be *t* ,condone use of *x*	M1
	F(*x*) $\begin{cases} 0 & x < 0 \\ \frac{x^3}{12} & 0 \le x \le 2 \\ \frac{x}{4} - \frac{x^2}{48} + \frac{1}{4} & 2 < x \le 6 \\ 1 & x > 6 \end{cases}$	A1: second line correct A1: third line correct B1: first and fourth line correct they may use "otherwise" instead of $x < 0$ or $x > 6$ but not instead of both	A1 A1 B1
	NB: Condone use of < rather than $\le$ and vice versa		

Question Number	Scheme		Marks
(d)	$\frac{x}{4}-\frac{x^2}{48}+\frac{1}{4}=0.75$	M1: putting their line 2 or their line 3 = 0.75	M1 A1
	$x^2-12x+24=0$ oe	A1: The correct quadratic equation – like terms must be collected together	
	$x=\frac{12\pm\sqrt{144-4\times24}}{2}$	M1d: dep on previous M1 being awarded. A correct method for solving a 3 term quadratic equation = 0 leading to *x* = …Use either the quadratic formula or completing the square - If they quote a correct formula and attempt to use it, award the method mark if there are small errors. Where the formula is not quoted, the method mark can be implied from correct working with values but is lost if there is a mistake. If they attempt to factorise award M1 if they have $\left(x^2+bx+c\right)=(x+p)(x+q)$, where $\lvert pq\rvert=\lvert c\rvert$ leading to $x=...$ May be implied by a correct value for *x*	dM1 A1
	= 2.54 or $6-2\sqrt{3}$	A1: awrt 2.54 or $6-2\sqrt{3}$ or $6-\sqrt{12}$. If 2 values for *x* are given they must eliminate the incorrect one.	

Question Number	Scheme		Marks
		Notes	
4(a)	0.8	B1: cao	B1
(b)	0.25	B1: cao	B1
(c)	$\frac{(0.5-0)^2}{12}=\frac{1}{48}$ or awrt 0.0208	M1: for $\frac{(0.5\pm 0)^2}{12}$ or for $\int_0^{0.5} 2x^2\mathrm{d}x-(\text{their }(b))^2$ with some integration $x^n \to x^{n+1}$ A1: $\frac{1}{48}$ or awrt 0.0208 or awrt 2.08×10^{-2}	M1A1
(d)	P(L > 0.4) = 0.2	P(L < 0.4) = 0.8	An awrt 0.123 award B1 M1 A1
	Y~ B(30, 0.2)	Y~ B(30, 0.8)	B1: using or writing B(30, their P(L < 0.4) or B(30, their P(L > 0.4) . If they have not written these probabilities in this part use answer from part (a) ie P(L < 0.4) = (a) or P(L > 0.4) = 1- (a)
	P($Y\leq$ 3) = 0.1227	P($Y\geq$ 4) = 0.1227	M1: dependent on previous B mark being awarded. Using B(30,P(L>0.4) with P($Y\leq$ 3) written or used **Or** B(30 P(L<0.4)) with P($Y\geq$ 4) written or used A1: awrt 0.123
(e)	$1-\left[4\times0.4-4\times0.4^2\right]=\frac{1}{25}$ or 0.04	M1: Using 1- F(0.4) or F(0.5) – F(0.4) or $\mathrm{P}(X\leq 0.5)-\mathrm{P}\left(X\leq 0.4\right)$. Must see some substitution of 0.4 A1: $\frac{1}{25}$ or 0.04 only	M1A1
(f)	Po(4)	B1ft: using or writing Po(4) **NB** for ft they must either write 100 × "their 0.04" and use Poison or write Po("their λ ") Allow P instead of Po	B1ft
	P($X\geq$ 8) = 1- P($X\leq$7)	M1 using or writing 1- P($X\leq$7) If using normal approximation, they must either write this or $\frac{7.5-4}{2}$ or $\frac{7.5-4}{\sqrt{3.84}}$ or $\frac{7.5-4}{\text{awrt }1.96}$ or $\frac{7.5-20}{\sqrt{16}}$	M1
	= 1 – 0.9489 = 0.0511	A1 awrt 0.0511	A1

Question Number	Scheme		Marks
		Notes	
5(a)	X~Po(4) P(X = 0) = 0.0183 P($X \geq 8$) = 0.0511 P($X \leq 1$) = 0.0916 P($X \geq 9$) = 0.0214	M1: using Po(4), need to see a probability from Po(4), need not be one of the 4 given here. May be implied by a single correct CR	M1 A1 A1
	CR $X = 0$ $X \geq 9$	A1: $X = 0$ or $X \leq 0$ or $X < 1$ A1: $X \geq 9$ or $X > 8$ Any letter(s) may be used instead of X eg CR or Y or in words **SC** candidates who write P(X = 0) and $\mathrm{P}(X \geq 9)$ award M1A1 A0 **NB** Candidates who write $8 < x \leq 0$ oe get M1A0A0	
(b)	$H_0 : \lambda = 4$ $H_1 : \lambda \neq 4$	B1: both hypotheses correct, labelled H_0 or NH or H_n and H_1 or AH or H_a may use λ or μ. These must be seen in part (b)	B1
	There is evidence that ***Liftsforall's*** claim is true **or** There is insufficient evidence to doubt ***Liftforall's*** claim	B1: ft their CR only, Do not ft hypotheses.Needs to include the word ***Liftsforall.*** If no Critical region stated in part (a) award B0 or $\mathrm{P}(X \leq 3) =$ awrt 0.434 and a correct conclusion.	B1ft
(c)	0.0183 + 0.0214 = 0.0397	B1: Awrt 0.0397	B1
(d)	P($B \leq 3 \mid B \sim$ Po(6)) = 0.1512	M1: using Po(6) and writing or using P($B \leq 3$) oe. A1: awrt 0.151	M1 A1
	$X \sim$ B(4, 0.1512)	B1ft: dep on M1 being awarded. Using or writing B(4,"their 0.151") for use they need $(1-p)^4$ or $p(1-p)^3$ or $p^2(1-p)^2$	dB1ft
	Alternative method for first 3 marks		
	P($B \geq 4 \mid B \sim$ Po(6)) = 0.8488	M1: using Po(6) and writing or using P($B \geq 4$) oe A1: awrt 0.849	M1 A1
	$Y \sim$ B(4, 0.849)	B1ft: dep on M1 being awarded. Using or writing B(4,"their 0.849") for use they need $(p)^4$ or $p^3(1-p)$ or $p^2(1-p)^2$	dB1ft
	If $0 < p < 0.5$		
	P($X \leq 1$) = P(X = 0) + P(X = 1)	M1: using or writing P(X = 0) + P(X = 1) oe	M1
	$(1-0.1512)^4 + 4\times(1-0.1512)^3 \times 0.1512$	M1: $(1-p)^4 + 4\times(1-p)^3 \times p$ oe	dM1
	= 0.889	A1: awrt 0.889	A1
	If $0.5 < p < 1$		
	P($Y \geq 3$) = P(Y = 3) + P(Y = 4)	M1: using or writing P(X = 3) + P(X = 4) oe	M1
	$4\times(0.8488)^3 \times 0.1512 + (0.8488)^4$	M1: $(p)^4 + 4\times(p)^3 \times(1-p)$ oe	dM1
	= 0.889	A1: awrt 0.889	A1
NB: a correct answer implies full marks, lose the final A mark if got awrt 0.889 and go on to do more work			

Question Number	Scheme		Marks
	NB: All powers of 1 **must** be simplified for the Accuracy(A) marks		
		notes	
6(a)	$\left[\frac{kx^{n+1}}{n+1}\right]_0^1 = 1$	M1: attempting to integrate $x^n \to x^{n+1}$ and putting equal to 1, ignore limits A1: correct integration	M1A1
	$k = n + 1$	A1: $k = n + 1$ Do **not** accept $\frac{n+1}{1^{n+1}}$	A1
(b)	$\int_0^1 kx^{n+1}\mathrm{d}x = \left[\frac{kx^{n+2}}{n+2}\right]_0^1$	M1: Writing or using $\int_0^1 kx^{n+1}\mathrm{d}x$, ignore limits. Allow $\int_0^1 kx(x)^n\mathrm{d}x$ Allow substitution of their k A1: correct integration $\frac{kx^{n+2}}{n+2}$	M1A1
	$= \frac{n+1}{n+2}$	A1: correct answer only- must be in terms or n	A1cao
(c)	$\int_0^1 kx^{n+2}\mathrm{d}x = \left[\frac{kx^{n+3}}{n+3}\right]$	M1: Attempting to integrate $\int_0^1 kx^{n+2}\mathrm{d}x$, $x^{n+2} \to x^{n+3}$, ignore limits. Do not allow substitution of k if it has x in it. This must be on its own with no extra bits added on.	M1 A1cao
	$= \frac{n+1}{n+3}$	A1: correct answer only SC if they have $\frac{k}{n+2}$ as answer to part(b) award A1 for $\frac{k}{n+3}$	
(d)	Var $(X) = \frac{3}{5} - \left(\frac{3}{4}\right)^2 = \frac{3}{80}$	M1: using "their(c)" − ["their(b)"]^2 with $n = 2$ or correct Var(X) Using $\int_0^1 kx^4\mathrm{d}x - \left[\int_0^1 kx^3\mathrm{d}x\right]^2$ for Var(X)	M1
	Var $(3X) = 9$ Var (X)	M1: for writing or using 9 Var (X) or 3^2Var(X)	M1 A1cso
	$= \frac{27}{80}$ oe or 0.3375 or 0.338	A1: cso	

Question Number	Scheme		Marks
		Notes	
7	**NB: If there is a fully correct table award full marks.**		
	P(10) = 0.2, P(20) = 0.4 and P(50) = 0.4	B1: using P(10) = 0.2 (p) P(20) = 0.4(q) and P(50) = 0.4(r) may be seen in calculations or implied by a correct probability.	B1
	Median 10, 20, 50	B1: three correct medians and no extras.	B1
	P(Median 10) = $0.2^3+3\times0.2^2\times0.4+3\times0.2^2\times0.4$ **or** $0.2^3+3\times0.2^2\times0.8$	M1: allow if $(p+q+r)$=1 and use $p^3+3\times p^2\times q+3\times p^2\times r$ **or** $p^3+3\times p^2\times(q+r)$ look for $\frac{1}{125}+\frac{6}{125}+\frac{6}{125}$	See below for how to award
	P(Median 50) = $0.4^3+3\times0.4^2\times0.2+3\times0.4^2\times0.4$ **or** $0.4^3+3\times0.4^2\times0.6$	M1: allow if $(p+q+r)$=1 and use $r^3+3\times r^2\times p+3\times r^2\times q$ **or** $r^3+3\times r^2\times(p+q)$ Look for $\frac{8}{125}+\frac{12}{125}+\frac{24}{125}$	
	P(Median 20) = $3\times0.2\times0.4^2+6\times0.2\times0.4\times0.4+0.4^3+3\times0.4^2\times0.4$	M1: allow if $(p+q+r)$=1 and use $3\times p\times q^2+6\times p\times q\times r+q^3+3\times q^2\times r$ $\frac{12}{125}+\frac{24}{125}+\frac{8}{125}+\frac{24}{125}$	
	<u>How to award the M marks</u> – Allow the use of 1, 2 and 5 for the medians for the method marks **M1** any correct calculation (implied by correct answer) for P(m = 10) or P(m = 20) or P(m = 50) **M1** any 2 correct calculations (implied by 2 correct answers) P(m = 10) or P(m = 20) or P(m = 50) **M1** any 3 correct calculations (implied by 3 correct answers) for P(m = 10) and P(m = 20) and P(m = 50) or 3 probabilities that add up to 1 providing it is 1 – their 2 other calculated probabilities. Do **not** allow $\frac{1}{5}\ \frac{2}{5}\ \frac{2}{5}$ **NB** if they do not have a correct answer their working must be clear including the addition signs.		
	<table><tr><td>median</td><td>10</td><td>20</td><td>50</td></tr><tr><td></td><td>0.104</td><td>0.544</td><td>0.352</td></tr><tr><td></td><td>Or $\frac{13}{125}$</td><td>Or $\frac{68}{125}$</td><td>Or $\frac{44}{125}$</td></tr></table>	A1: awrt any 1 correct A2: awrt all 3 correct These do not need to be in a table as long as the correct probablity is with the correct median(10, 20 & 50) **NB: Do Not allow the use of 1,2 and 5 for the medians for the A marks**	A2

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