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Mark Scheme (Results)

Summer 2013

GCE Statistics 2 (6684/01R)

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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 $\surd$ 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.

8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme

Question Number	Scheme	Marks
1.		
(a)	(1, 1, 1), (5, 5, 5), (1, 5, 5), (1, 5, 1) (1,1,1); (5,5,5); (1, 5, 5); (5, 1, 5); (5, 5, 1) (5, 1, 1); (1, 5, 1); (1, 1, 5)	B1 B1 **(2)**
(b)	r : 0 and 4 P(R = 0) = $\frac{9}{27}$ or $\frac{1}{3}$ P(R = 4) = $\frac{18}{27}$ or $\frac{2}{3}$	B1 M1d A1 **(3)** **[5]**
	Notes	
(a)	1st B1 for any two of the triples 2nd B1 for all 8 cases. No incorrect extras – condone repeats. Allow (1, 5, 5) (x 3) and (1, 1, 5) (x 3) instead of writing all three cases down	
(b)	B1 for both values of r M1 d dependent on previous B1. For an attempt to evaluate one of the probabilities for r correctly e.g. for r = 0; $\left(\frac{2}{3}\right)^3+\left(\frac{1}{3}\right)^3$ and for r = 4; $3\times\left(\frac{1}{3}\right)^2\times\left(\frac{2}{3}\right)+3\times\left(\frac{1}{3}\right)\times\left(\frac{2}{3}\right)^2$ **Working must be shown.** A1 for both values of r and their correct corresponding probabilities. Allow awrt 0.333 and 0.667 **NB** Correct answer with no working will gain B1M0A0	

Question Number	Scheme	Marks
2.		
(a)	F(2) = 1 gives: $\frac{1}{4}\left(2^3-4\times2^2+2k\right)=1$	M1
	$\underline{\boldsymbol{k = 6}}$	A1
		(2)
(b)	$f(y) = \frac{d}{dy}\left(F(y)\right)=\frac{1}{4}\left(3y^2-8y+"6"\right)$	M1A1ft
	$f(y)=\begin{cases}\frac{1}{4}\left(3y^2-8y+6\right) & 0\le y\le 2\\ 0 & \text{otherwise}\end{cases}$	A1
		(3)
(c)	$P(Y>1) = 1 - F(1) = 1-\frac{1}{4}\left(1^3-4\times1^2+k\right)$	M1
	$= \frac{1}{4}$ (o.e.)	A1
		(2)
		[7]

	Notes
(a)	M1 for an attempt to use F(2) = 1. Clear attempt to form a linear equation for *k*
(b)	M1 for some correct differentiation $y^n \to y^{n-1}$ 1st A1ft for $3y^2-8y+"6"$, follow through their value of *k* or even *k* as a letter 2nd A1 for a fully correct solution including the 0 otherwise.
(c)	M1 for clear use of 1 – F(*y*) or attempt at integrating f(*y*); at least one correct term with correct coefficient, and using limit of 1 and 2 A1 for $\frac{1}{4}$ or any exact equivalent

Question Number	Scheme	Marks
3.		
(a)	$\frac{1}{2}(a+b)=23$ and $\frac{1}{12}(b-a)^2=75$	B1B1
	$a+b=46$ and $b-a=\sqrt{12\times75}\,(=30)$	M1
	Adding gives $2b = 76$	M1
	$\underline{b = 38}$ and **$\underline{a = 8}$**	A1 A1 **(6)**
	alternative	
	$\frac{1}{2}(a+b)=23$ and $\frac{1}{12}(b-a)^2=75$	B1B1
	$a+b=46$ and hence $(46-2a)^2=900$ oe	M1
	$a^2-46a+304=0$	
	$(a-8)(a-38)=0$	M1
	$\underline{b = 38}$ and **$\underline{a = 8}$**	A1 A1 **(6)**
(b)	P(23 < X < c) = 0.5 – 0.32 or $c = 28.4$ and prob $= \frac{5.4}{30}$	M1
	= **$\underline{0.18}$**	A1 **(2)** **[8]**

	Notes
(a)	1st B1 for at least one correct equation using given formulae 2nd B1 for any 2 correct equations for a and b using both 23 and 75 1st M1 for rearranging to get two linear equations in a and b *or* rearranging and substituting linear equation into quadratic. 2nd M1 for solving i.e. eliminating one variable leading to a linear equation in one variable *or* solving their quadratic correctly by any method. 1st A1 for $b = 38$ 2nd A1 for $a = 8$ **SC** If they get $b = 8$ and $a = 38$ or they give two sets of values and do not eliminate one then they can get B1B1M1M1A1A0
(b)	M1 for a correct method, e.g. a correct expression or seeing calculation for c and calculation for probability A1 for 0.18 only

Question Number	Scheme	Marks
4.		
(a)	$\int \mathrm{f}(x)\,\mathrm{d}x = k\left[3x + x^2 - \frac{x^3}{3}\right]$	M1
	$\int_0^3 \mathrm{f}(x)\,\mathrm{d}x = 1$ gives $k\left[\left(9+9-\frac{27}{3}\right)-(0)\right] = 1$	M1
	So $k = \frac{1}{9}$ (*)	A1cso
		(3)
(b)	$\mathrm{f}'(x) = k(2-2x)$	M1
	$\mathrm{f}'(x) = 0$ implies $x = 1$ so **<u>mode = 1</u>**	A1
		(2)
(c)	$\mathrm{E}(X) = \int_0^3 \frac{1}{9}\left(3x + 2x^2 - x^3\right)\,\mathrm{d}x$	M1
	$= \frac{1}{9}\left[\frac{3x^2}{2} + \frac{2x^3}{3} - \frac{x^4}{4}\right]_0^3$	M1dA1
	$= \left\{\frac{1}{9}\left[\left(\frac{3}{2}\times 9 + \frac{2}{3}\times 27 - \frac{81}{4}\right) - 0\right]\right\} = \frac{5}{4}$	A1
		(4)
(d)	Mean > mode	M1
	So **<u>positive skew</u>**	A1
		(2)
		[11]

	Notes	
(a)	**NB** This is a 'Show that so working must be seen'	
	1st M1 for some correct integration $x^n \to x^{n+1}$ for at least one term	
	2nd M1 for some correct use of the limit 3 and at least implied use of limit 0 and put =1	
	A1cso for correct solution with no incorrect working seen.	
(b)	M1 for attempt to differentiate and putting = 0. At least one correctly differentiated x term. or for an alternative method for finding the maximum such as completing the square and selecting the corresponding x value or using a sketch and symmetry.	
	A1 for mode = 1	
(c)	1st M1 for clear attempt to use $x\mathrm{f}(x)$ with an intention of integrating (Integral sign enough) Ignore limits. Must substitute in f(x)	
	2nd M1d dependent on 1st M being awarded. For some correct integration...at least one correct term with the correct coefficient.	
	1st A1 for fully correct (possibly un-simplified) integration. Ignore limits	
	2nd A1 for answer of 5/4 or 1.25 or some other exact equivalent	
(d)	M1 for a comparison of mean and mode (ft their values of mode and mean). Do **not** allow median.	
	A1 for positive skew only (provided this is compatible with their values and comparison)	

Question Number	Scheme	Marks
5.	[X = number of customers joining the queue in the next 10 mins ~Po(3)]	

Question Number	Scheme	Marks
(a)	$P(X = 4) = P(X \leq 4) - P(X \leq 3)$ or $\frac{e^{-3}3^4}{4!}$	M1
	$0.8153 - 0.6472 = 0.1681$ or $0.1680313...$ (awrt **0.168**)	A1
		(2)
(b)	Y [= number of customers joining the queue in the next 20 mins] ~ Po(6)	B1
	$P(Y > 10) = 1 - P(Y \leq 10)$	M1
	$= 1 - 0.9574 = 0.0426(209...)$ (awrt **0.0426**)	A1
		(3)
(c)	$P(T > 3.5) =$ **0.3**	B1
		(1)
(d)	$C \sim B(5, 0.3)$	M1
	$P(C \geq 3) = 1 - P(C \leq 2)$	M1
	$= 1 - 0.8369 = 0.1631$ (0r 0.16308..) (awrt **0.163**)	A1
		(3)
(e)	P(Bethan is served in < 4 minutes) = 0.8 (o.e.)	B1
	J = number joining the queue in 4 mins has $J \sim Po(1.2)$	M1
	$P(J = 0) = e^{-1.2} = 0.30119...$	A1
	P(Bethan is served and $J = 0$) $= 0.8 \times e^{-1.2} = 0.240955...$ (awrt **0.241**)	A1
		(4)
		[13]

	Notes
(a)	M1 for a correct method. May use incorrect λ A1 for awrt 0.168
(b)	B1 for writing or using Po(6) M1 for writing or using $1 - P(Y \leq 10)$ A1 for awrt 0.0426
(d)	1st M1 for identifying that $C \sim B(5, 0.3)$. Follow through their 0.3. May be implied 2nd M1 for writing or using $1 - P(C \leq 2)$ A1 for awrt 0.163 SC if they use normal distribution they may get M0 M1 A0 if they find $P(C \geq 2.5)$
(e)	B1 for 0.8 for P(Bethan is served in the next 4 minutes) M1 for identifying Po(1.2) A1 for $e^{-1.2}$ or awrt 0.301... A1 for awrt 0.241

Question Number	Scheme	Marks
6.	[X = the number of raisins in a mini-muffin]	
(a)	$X \sim$ Po(8)	B1
	e.g. P($X \leq 3$) = 0.0424, P($X \leq 13$) = 0.9658 so P($X \geq 14$) = 0.0342	M1
	So Critical Region is $X \leq 3$ or $X \geq 14$	A1 A1 **(4)**
(b)	0.0424 + 0.0342	M1
	= **0.0766** (or better)	A1 **(2)**
(c)	$H_0 : \lambda = 8$ (or μ=80) $H_1 : \lambda > 8$ (or $\mu > 80$)	B1
	[R = no. of raisins in 10 muffins. $R \sim$ Po(80).] Use $Y \sim$ N(80, 80)	M1A1
	P($R \geq 95$) $\simeq$ P($Y \geq 94.5$)	M1
	$= P\left(Z > \frac{94.5-80}{\sqrt{80}}\right)$	M1
	= P(Z > 1.62...) = 1 – 0.9474 = awrt **0.053**	A1
	Probability is greater than 0.05 so not significant (accept H_0)	M1
	Insufficient evidence to support the bakery's claim Or insufficient evidence of an increase in the (mean) number of raisins per muffin	A1cso **(8)** **[14]**

	Notes
(a)	B1 for Po(8) seen or implied by use M1 for clear evidence of use of Po(8), may be implied by a correct CR (allow written as a probability statement) or a probability seen in part(b). If they give 3 and 14 1st A1 for $X \leq 3$ or $0 \leq X \leq 3$ or 0,1,2,3 or [0,3] Allow any letter 2nd A1 for $X \geq 14$ or $[14, \infty)$ condone $[14, \infty]$ Allow any letter These A marks must be for statements with X only – not in prob statements
(b)	M1 for showing they are adding together the two probabilities that correspond to their CR **or** allow M1 A1for correct answer
(c)	B1 for both hypotheses. Must be in terms of λ or μ, 8 or 80 can be swapped 1st M1 for normal approx 1st A1 E(Y) = 80 and Var(Y) = 80 (or correct st. dev seen somewhere) 2nd M1 for use of a continuity correction 94.5 or 95.5 3rd M1 Standardising using their mean and their sd, If they have not written down a mean and sd then these need to be correct here to award the mark. They must also use 94.5, 95.5 or 95 and find the correct area ie using 1 - P(Z $\leq$ "their 1.62") 2nd A1 for awrt 0.053 or awrt 0.947 4th M1 for a correct statement based on their probability and 0.05 3rd A1 cso for a correct contextualised statement and a fully correct solution with no errors seen. Need either bakery's claim or Raisins and muffin **NB** If Found P(X=95) they can get B1 M1 A1 M0M0A0M0A0

Question Number	Scheme	Marks
7.		

Question Number	Scheme	Marks
(a)	$X \sim B(20, 0.2)$	M1 A1 **(2)**
(b)	$S = 4X - 1(20 - X)$ $S = 5X - 20$	M1 A1cso **(2)**
(c)	$E(X) = 4$, $Var(X) = 3.2$ $E(S) = 5\times4 - 20 = 0$, $Var(S) = 5^2\,Var(X) = 80$	B1, B1 M1 A1 **(4)**
(d)	$S \geq 20$ implies $5X - 20 \geq 20$ [So $5X \geq 40$] $X \geq 8$ $P(S \geq 20) = P(X \geq 8) = 1 - P(X \leq 7)$ $= 1 - 0.9679 =$ **<u>0.0321</u>**	M1 A1 M1 A1 **(4)**
(e)	[Let C = no. Cameron gets correct. $C \sim B(100, 0.4)$] $Y \sim N(40, \sqrt{24}^2)$ $P(C > 50) \simeq P(Y > 50.5)$ $= P\left(Z > \frac{50.5 - 40}{\sqrt{24}}\right)$ $= P(Z > 2.14...) = 1 - 0.9838 = 0.0162$ or 0.016044.. (awrt **<u>0.016</u>**) N.B. exact Bin (0.01676...) Poisson approx (0.0526...)	M1A1 M1 M1 A1 **(5)** **[17]**

	Notes
(a)	M1 for "binomial" or B(... A1 for $n = 20$ and $p = 0.2$
(b)	**NB** this is a 'show that' so working must be shown M1 for attempt at any correct expression for S that uses 4 and – 1 (1 may not be seen) A1cso for correct expression derived. No incorrect working seen and M1 scored.
(c)	1st B1 for $E(X) = 4$ seen. Condone E(S) = 4. May be implied by correct E(S) or be seen in the calculation for E(S) 2nd B1 for $Var(X) = 3.2$ seen. Condone $Var(S) = 3.2$. May be implied by correct Var(S) or be seen in the calculation for Var(S) M1 for a correct formula for $E(S)$ or $Var(S)$ – follow through their $E(X)$ and $Var(X)$ may be implied by either answer being correct A1 for 0 and 80 correctly assigned.
(d)	1st M1 for an attempt to solve the inequality for X 2nd M1 for $1 - P(X \leq 7)$
(e)	1st M1 for use of normal approx. and mean = 40 1st A1 for Var = 24 or st. dev = $\sqrt{24}$ May be implied by later work 2nd M1 49.5 or 50.5 3rd M1 Standardising using their mean and their sd, If they have not written down a mean and sd then these need to be correct here to award the mark. They must also use 50.5, 49.5 or 50 and find the correct area ie using 1 - P(Z ≤ "their 2.14"), 2nd A1 for awrt 0.016

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