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Mark Scheme (Results)

Summer 2013

GCE Statistics S2 (6684/01)

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Summer 2013
Publications Code UA036999

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.
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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)	(5,5,5) or (1,5,5) or (2,5,5) (5,5,5) (5,5,1) (5,1,5) (1,5,5) (5,5,2) (5,2,5) (2,5,5) or (5,5,5) **and** (5,5,1) ($\times 3$) **and** (5,5,2) ($\times 3$)	B1 B1 (2)
1(b)	(5,5,5) $\left(\frac{3}{10}\right)^3 = \frac{27}{1000} = 0.027$ (5,5,1) $3\times\frac{1}{2}\times\left(\frac{3}{10}\right)^2 = \frac{135}{1000} or \frac{27}{200} = 0.135$ (5,5,2) $3\times\frac{1}{5}\times\left(\frac{3}{10}\right)^2 = \frac{54}{1000} = \frac{27}{500} = 0.054$ $P(M=5) = \left(\frac{3}{10}\right)^3 + 3\times\frac{1}{2}\times\left(\frac{3}{10}\right)^2 + 3\times\frac{1}{5}\times\left(\frac{3}{10}\right)^2 = \frac{27}{125} = 0.216$ oe	B1 M1 A1A1 (4)
1(c)	$P(M=1) = (0.5)^3 + 3(0.5)^2(0.2) + 3(0.5)^2(0.3)$ $= 0.5$ $P(M=2) = \left(\frac{1}{5}\right)^3 + 3\times\left(\frac{1}{5}\right)^2\times\frac{1}{2} + 3\times\left(\frac{1}{5}\right)^2\times\frac{3}{10} + 6\times\frac{1}{2}\times\frac{1}{5}\times\frac{3}{10}$ $= 0.284$ or $\frac{71}{250}$ oe m | 1 | 2 | 5 $P(M=m)$ | 0.5 | 0.284 | 0.216	M1 A1 M1 A1 A1 (5) Total 11 marks

	Notes
1(a)	1st B1 for two of the given triples, any order 2nd B1 for all 7 cases. no incorrect extras
1(b)	B1 $\left(\frac{3}{10}\right)^3$ *or* 0.027 oe. This can be a single term in a summation M1 either "3" $\times\frac{1}{2}\times\left(\frac{3}{10}\right)^2$ **or** "3" $\times\frac{1}{5}\times\left(\frac{3}{10}\right)^2$ oe. May omit the 3 × or have another positive integer in place of the 3. These may be seen as a single term in a summation A1 $\left(\frac{3}{10}\right)^3 + 3\times\frac{1}{2}\times\left(\frac{3}{10}\right)^2 + 3\times\frac{1}{5}\times\left(\frac{3}{10}\right)^2$ oe A1 0.216 oe
1(c)	1st M1 correct calculation for $P(M=1)$ **or** $P(M=2)$, working must be shown and **not** implied by a correct answer. 1st A1 either $P(M=1)$ **or** $P(M=2)$ correct 2nd M1 correct calculation for both $P(M=1)$ **and** $P(M=2)$, **or** their probabilities adding up to 1, but do not allow probabilities of 0.5, 0.2 and 0.3 2nd A1 both $P(M=1)$ **and** $P(M=2)$ correct 3rd A1dep on both M marks awarded. All three values written down with their correct probabilities. They must be in part (c) but they do not need to be in a table. **NB** A fully correct table with no working will get M0 A0 M1 A1 A0.

Question Number	Scheme	Marks

2(a)	$P(X = 1) = 0.25e^{-0.25} = 0.1947$ awrt 0.195	M1A1 (2)
2(b)	$X \sim Po(1.5)$ $P(X > 2) = 1 - P(X \leq 2)$ $= 1 - 0.8088$ $= 0.1912$ awrt 0.191	B1 M1 A1 (3)
2(c)	$[\lambda = 300 \times 0.25 = 75]$ $X \sim N(75,75)$ $P(X < 90) = P(X \leq \frac{89.5-75}{\sqrt{75}})$ $= P(Z \leq 1.6743..)$ = awrt 0.953 or 0.952	 B1 B1 M1M1 A1 (5) Total 10 marks
	Notes	
2(a)	M1 $0.25e^{-0.25}$ o.e	
2(b)	B1 stating or using Po(1.5) M1 stating or using $1 - P(X \leq 2)$	
2(c)	1st B1 for normal approximation and correct mean 2nd B1 Var (X) = 75or sd = $\sqrt{75}$ or awrt 8.66 (may be given if correct in standardisation formula) 1st M1 using either 89.5 or 88.5 2nd M1 Standardising using their mean and their sd, using [89.5, 88.5 or 89] and for finding correct area **NB** use of Poisson gives an answer of 0.9498 and gains no marks	

Question Number	Scheme	Marks
3(a)	$X \sim$Po(7) P(X >10) = 1 - P($X \leq 10$) = 1- 0.9015 = 0.0985 awrt 0.0985	B1 M1 A1 (3)
3(b)	P($X > d$) < 0.05 **Or** P($X \geq d$) < 0.05 P($X \leq d$) > 0.95 P($X < d$) > 0.95 P($X \leq 11$) = 0.9467 P($X < 12$) = 0.9467 P($X \leq 12$)= 0.9730 P($X < 13$) = 0.9730 Least number of games =12 Least number of games 13	 M1 A1 A1 (3)
3(c)	H_0: $\lambda = 1, (\mu = 28)$ H_1: $\lambda > 1 (\mu > 28)$ $Y \sim$Po(28) approximated by N(28,28) P($Y \geq 36$) =P($Z \geq \frac{35.5-28}{\sqrt{28}}$) $1.6449 = \frac{x - 0.5 - 28}{\sqrt{28}}$ = P($Z \geq 1.42$) = 0.0778 or 1.42 < 1.6449 CR $X \geq 37.2$ 0.0778 > 0.05 so do not reject H_0/not significant. Not in CR There is no evidence that the average **rate** of **sales** per day has **increased**.	B1 B1 M1M1 A1 M1 A1cso (7) Total 13 marks

	Notes
3(a)	B1 stating or using Po(7) M1 stating or using 1 - P($X \leq 10$)
3(b)	M1 using or writing P($X > d$) < 0.05 or P($X < d$) > 0.95 (condone ≥ instead of > and ≤ instead of <) May be implied by correct answer. Different letters may be used. 1st A1 P($X \leq 12$)/ P($X < 13$) = awrt 0.973 **or** P($X \leq 11$) / P($X < 12$) = awrt 0.947 May be implied by a correct answer 2nd A1 12 or 13 **NB** An answer of 12/13 on its own with no working gains M1A1A1
3(c)	1st B1 both hypotheses correct using λ or μ, **and** 1 or 28 2nd B1 for writing or using a normal approximation with correct mean and Var (may be given if sd correct in standardisation formula) 1st M1 for use of a continuity correction 35.5 or 36.5 or $x \pm 0.5$ 2nd 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 use [35.5, 36.5, 36, x or $x \pm 0.5$] For CR must have = awrt 1.64 or 1.65 1st A1 awrt 0.0778 or 0.9222 or the statement 1.42 < awrt 1.65/1.64 or CR $X \geq 37.2$ / $X > 37.2$ 3rd M1 a correct conclusion for their probability. May be implied by a correct contextual conclusion. NB Non contextual contradicting statements gets M0 2nd A1 a correct contextual conclusion for their hypotheses and a fully correct solution with no errors seen. Need the words **"rate/average number", "sales"** and **"increased"**oe NB If found P($X = 36$) they can get B1B10M0A0M0A0

Question Number	Scheme	Marks

4(a)	$E(X) = \frac{5b}{2}$	B1 (1)
4(b)	$Var(X) = E(X^2) - (E(X))^2$ $= \int_b^{4b} \frac{x^2}{3b} dx - (\frac{5b}{2})^2$ $= \left[\frac{x^3}{9b}\right]_b^{4b} - \frac{25b^2}{4}$ $= \frac{63b^3}{9b} - \frac{25b^2}{4}$ $= \frac{3b^2}{4}$	M1 M1d A1cso (3)
4(c)	$Var(3 - 2X) = 4Var(X)$ $= 3b^2$	M1 A1 (2)
4(d)	$F(x) = \begin{cases} 0 & x < 1 \\ \frac{x-1}{3} & 1 \le x \le 4 \\ 1 & x > 4 \end{cases}$	B1B1 (2)
4(e)	$\frac{x-1}{3} = 0.5$ so $x = 2.5$	B1 (1)
Alt 4(b)	$Var(X) = \int_a^b \frac{(x-\bar{x})^2}{b-a} dx$ $= \int_b^{4b} \frac{4x^2 - 20bx + 25b^2}{12b} dx$ $= \left[\frac{\frac{4x^3}{3} - 10bx^2 + 25b^2x}{12b}\right]_b^{4b}$ $= \frac{9b^3}{12b}$ $= \frac{3b^2}{4}$	Total 9 marks M1 M1 A1cso(3)
	Notes	
4(b)	**NB remember the answer is given (AG) so they must show their working** 1st M1 for using $\int \frac{x^2}{3b} dx$ - (their (a))^2 limits not needed and condone missing dx. NB need not use the letter x but if they use b instead do not award if they cancel down to $\frac{b}{3}$ NB Check they have subtracted (their(a))^2 2nd M1 dependent on previous M being awarded. For some correct integration $x^n \to x^{n+1}$ and correct limits substituted at some point. condone $4b^3$ instead of $(4b)^3$ A1 for correct solution with no incorrect working seen.	
4(c)	M1 for writing or using 4Var(X)	
4(d)	1st B1 top **and** bottom line. Allow use of $\le$ instead of < and $\ge$ instead of > 2nd B1 middle row. Allow use of < instead of $\le$	

Question Number	Scheme	Marks
5(a)	$F(1) = 0, \frac{4}{10} + a + b = 0$	M1 A1

	$a = -\frac{3}{5}$ *or* $b = \frac{1}{5}$	
	F(2) = 1, $2 + 2a + b = 1$	M1
	Solving gives $a = -\frac{3}{5}, b = \frac{1}{5}$	A1
	Alt	(4)
	F(2) - F(1) = 1, $2 + 2a + b - \frac{4}{10} - a - b = 1$	M1
	$a = -\frac{3}{5}$	A1
	F(2) =1 **or** F(1) = 0	
	$2 - \frac{6}{5} + b = 1$ **or** $\frac{4}{10} - \frac{3}{5} + b = 0$	M1
	$b = \frac{1}{5}$	A1 (4)
5(b)	Differentiating cdf gives f(x) = $\frac{3}{10}x^2 + \frac{6}{10}x + a$, $1 \le x \le 2$	
	$= \frac{3}{10}(x^2 + 2x - 2)$	B1 cso (1)
5(c)	$E(X) = \int_1^2 \frac{3}{10}(x^3 + 2x^2 - 2x)dx$	M1
	$= \frac{3}{10}\left[\frac{1}{4}x^4 + \frac{2}{3}x^3 - x^2\right]_1^2$	M1d A1
	$= \frac{13}{8}$	A1 (4)
5(d)	F(1.425) = 0.24355, F(1.435) = 0.25227	M1A1
	0.25 lies between F(1.425)and F(1.435) hence result.	A1 (3)
	Notes	Total 12 marks
5(a)	1st M1 using F(1) = 0. Clear attempt to form a linear equation for a and b 1stA1 either a = -0.6 or b = 0.2 Previous M must be awarded 2nd M1 using F(2) = 1. Clear attempt to form a second linear equation for a and b 2nd A1 if 1st A1 awarded then both a and b must be correct otherwise award if either a = -0.6 or b = 0.2 **alt** 1st M1 F(2) - F(1) = 1. Leading to a value for a: 1st A1 a = -0.6 2nd M1 using F(2) = 1 or F(1) = 0. Leading to a value for b: 2nd A1 b = 0.2 NB correct values for a and b with no working scores no marks.	
5(b)	B1 They must differentiate and then factorise. cso	
5(c)	1st M1 for clear attempt to use $xf(x)$ with an intention of integrating (Integral sign enough) Ignore limits. Must substitute in f(x) or "their f(x)". 2nd M1d dependent on previous M being awarded for some correct integration… at least one correct term with the correct coefficient. 1st A1 for fully correct (possibly unsimplified) integration. Ignore limits 2nd A1 Accept 1.63 and 1.625 or some other exact equivalent	
5(d)	M1 expression showing substitution of 1.425 or 1.435 into F(x) [**or** into F(x) – 0.25] [or putting their F(x) = 0.25 and attempting to solve leading to x = ...] May be implied by either pair of the correct answers as given below for the 1st A1 1st A1 awrt 0.244 and awrt 0.252 [**or** awrt -0.00645 and awrt 0.00227] [or x = awrt 1.432] 2nd A1 0.25 lies between F(1.425)and F(1.435) [**or** change in sign therefore root between] [**or** "1.432" lies between 1.425 and 1.435 therefore root between]. Statement must be true for their method	

Question Number	Scheme	Marks
6(a)	$X \sim B(20,0.25)$	M1
	$P(X \ge 10) = 1 - 0.9861 = 0.0139$	A1
	$P(X \le 1) = 0.0243$	A1

	$(0 \leq)X \leq 1 \cup 10 \leq X(\leq 20)$	A1A1 (5)
6(b)	H_0: $p = 0.25$ H_1: $p < 0.25$ $X \sim B(20,0.25)$ $P(X \leq 3) = 0.2252$ or CR $X \leq 1$ Insufficient evidence to reject H_0, Accept H_0, Not significant. 3 does not lie in the Critical region. No evidence that the **changes** to the process have **reduced** the **percentage** of **defective articles (oe)**	 B1 M1A1 M1d A1cso (5) Total 10 marks
	Notes	
6(a)	M1 using B(20,0.25) may be implied by a correct CR (allow written as a probability statement) 1st A1 awrt 0.0139 2nd A1 awrt 0.0243 3rd A1 $X \leq 1$ or $0 \leq X \leq 1$ or [0,1] or 0,1 or equivalent statements 4th A1 $X \geq 10$ or $10 \leq X \leq 20$ or 10,11,12,13,14,15,16,17,18,19,20 or [10,20] or equivalent statements **NB** These two A marks must be for statements with X (any letter) only – not in probability statements and **SC** for CR written as $1 \geq X \geq 10$ gets A1 A0	
6(b)	B1 both hypotheses with p 1st M1 using B(20, 0.25) and finding $P(X \leq 3)$ or $P(X \geq 4)$ may be implied by a correct CR 1st A1 0.2252 (allow 0.7748) if not using CR or CR $X \leq 1$ or $X < 2$ 2nd M1dependent on previous M being awarded. A correct statement (do not allow if there are contradicting non contextual statements) A1cso Conclusion must contain the words **changes/new process oe**, **reduced oe number/percentage oe** , and **defective articles/defectives**. There must be no incorrect working seen.	

Question Number	Scheme	Marks
7(a)	Distribution $X \sim B(n,0.1)$	B1 (1)
7(b)	$Y \sim B(10,0.1)$	B1
	$P(Y \geq 4) = 1 - P(Y \leq 3)$	M1
	$= 1 - 0.9872$	
	$= 0.0128$	A1 (3)
7(c)		
	$0.9^n < 0.05$ or $1 - (0.9)^n > 0.95$	M1
	$n > 28.4$	A1
	$n = 29$	A1
	alternative	
	B(28,0.1): P(0) = 0.0523	M1
	B(29,0.1): P(0) = 0.0471	A1
	$n = 29$	A1cao (3)
7(d)	$C \sim Po(5)$	B1
	$P(C > 10) = 1 - P(C \leq 10)$	M1
	$= 1 - 0.9863$	
	$= 0.0137$	A1 (3)
		Total marks 10

	Notes
7(a)	B1 for "binomial" or B(…
7(b)	B1 writing or using B(10,0.1) M1 writing or using $1 - P(Y \leq 3)$ A1 awrt 0.0128
7(c)	M1 $(0.9)^n < 0.05$,oe, or $(0.9)^n = 0.05$,oe, or $(0.9)^n > 0.05$, oe, or seeing 0.0523 or seeing 0.0471 1st A1 [P(0)] = 0.0471 or getting awrt 28.4 May be implied by correct answer. 2nd A1 cao $n = 29$ should not come from incorrect working. **NB** An answer of 29 on its own with no working gains M1A1A1
7(d)	B1 writing or using Po(5) M1 writing or using $1 - P(C \leq 10)$ A1 awrt 0.0137

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Order Code UA036999 Summer 2013

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