Mark Scheme (Results)

January 2013

GCE Statistics S2 (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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Unless indicated in the mark scheme a correct answer with no working should gain full marks for that part of the question.

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.

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.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used.

- 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 incorrect 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. The maximum mark allocation for each question/part question(item) is set out in the marking grid and you should allocate a score of '0' or '1' for each mark, or "trait", as shown:

	0	1
aM		●
aA	●	
bM1		●
bA1	●	
bB	●	
bM2		●
bA2		●

January 2013
6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
1(a)	n large	B1
	p small	B1
		(2)
(b)	Let X be the random variable the number of letters delivered to the wrong house	
	$X \sim B(1000,0.01)$	
	Po(10)	B1
	$P(X \geq 4) = 1 - P(X \leq 3)$	M1
	$= 1 - 0.0103$	
	$= 0.9897$	A1
		(3)
		Total 5

Notes

(a) B1 Accept n (the number of trials) large / high / big / $n > 50$ (accept any number larger than 50)

B1 Accept p (the probability) small / close to 0 / $p < 0.2$ (accept any number less than 0.2). Do not accept low.

These must appear in part (a).

(b) B1 writing or using Po(10)

M1 using a Poisson (λ need not equal 10) and for writing or using $1 - P(X \leq 3)$. (Do not accept writing $1 - P(X < 4)$ unless they have used $1 - P(X \leq 3)$).

A1 0.9897 cao must be 4 dp

NB

An awrt 0.990 on its own gains B0M0A0 unless there is evidence that Po(10) is used. In which case it gets B1M1A0

Using B(1000,0.01) gives 0.989927…. and gains B0M0A0

Question Number	Scheme	Marks
2 (a)	Let X be the random variable the number power cuts.	
	$X \sim$ Po(3)	B1
(i)	$P(X = 7) = P(X \leq 7) - P(X \leq 6)$ or $\frac{e^{-3}3^7}{7!}$	M1
	$= 0.9881 - 0.9665$	
	$= 0.0216$ awrt 0.0216	A1
(ii)	$P(X \geq 4) = 1 - P(X \leq 3)$	M1
	$= 1 - 0.6472$	
	$= 0.3528$ awrt 0.353	A1
		(5)
(b)	$X \sim$ Po(30)	
	N(30,30)	M1A1
	$P(X < 20) = P\left(Z < \frac{19.5-30}{\sqrt{30}}\right)$	M1M1 A1
	$= P(Z < -1.92)$	
	$= 1 - 0.9726$	
	$= 0.0274 - 0.0276$	A1
		(6)
	Notes	**Total 11**
(a)	B1 Writing or using Po(3) in either (i) or (ii)	
(i)	M1 writing or using $P(X \leq 7) - P(X \leq 6)$ or $\frac{e^{-\lambda}\lambda^7}{7!}$	
(ii)	M1 writing or using $1 - P(X \leq 3)$. (Do not accept writing $1 - P(X < 4)$ unless they have used $1 - P(X \leq 3)$).	
(b)	1st M1 for writing or using a normal approximation 1st A1 for correct mean and sd (may be given if correct in standardisation formula) 2nd M1 Standardising using their mean and their sd **and** using [18.5, 19, 19.5, 20 or 20.5] **and** for finding correct area by doing **1 – P(*Z* ≤ "their 1.92")** If they have not written down a mean and sd then these need to be correct here to award the mark 3rd M1 for attempting a continuity correction (19 ± 0.5) i.e. 18.5 or 19.5 **only**. 2nd A1 for $\pm\frac{19.5-30}{\sqrt{30}}$ or $\pm$ awrt 1.9 or better. 3rd A1 awrt 0.0274, 0.0275 or 0.0276 **SC using P(*X*< 20.5/19.5) – P(*X*< 19.5/18.5) can get M1A1 M0M1A0A0**	

Question Number	Scheme		Marks
3(a) (i)	$P(X < 5) = 0.8424$	awrt 0.842	B1
(ii)	$P(X \geq 7) = 1 - P(X \leq 6)$		M1
	$= 1 - 0.9857$		
	$= 0.0143$	awrt 0.0143	A1
			(3)
(b)	$P(X = 0) = (1 - p)^{12}$		
	$(1 - p)^{12} = 0.05$		M1
	$(1 - p) = \sqrt[12]{0.05}$		M1
	$p = 0.221$	awrt 0.221	A1
			(3)
(c)	Variance $= 12p(1 - p)$		
	$12p(1 - p) = 1.92$		M1
	$12p - 12p^2 = 1.92$		
	$12p^2 - 12p + 1.92 = 0$ or $p^2 - p + 0.16 = 0$ or $25p^2 - 25p + 4 = 0$		
	$p = \frac{12 \pm \sqrt{12^2 - 4 \times 12 \times 1.92}}{24}$ or $(5p - 1)(5p - 4) = 0$		M1
	$p = 0.2$ or 0.8		A1,A1
			(4)
	Notes		**Total 10**
(a) (ii)	M1writing or using $1 - P(X \leq 6)$ Do not accept $1 - P(X < 7)$ unless $1 - P(X \leq 6)$ has been used		
(b)	1st M1 $(1 - p)^n = 0.05$ 2nd M1 taking nth root. If they have used logs they need to get to a correct expression for $1 - p$ for their equation.		
(c)	1st M1 $12p(1 - p) = 1.92$ o.e. 2nd M1 solving a quadratic either by factorising / completing the square / or formula. Working must either be correct for **their** quadratic (they may use a quadratic from an incorrect rearrangement) **or** they must have written the appropriate formula down correctly and only made 1 error substituting into it. May be implied by a correct value of p. 1st A1 for 0.2 2nd A1 for 0.8		

Question Number	Scheme	Marks
4 (a)	Mean = 1	B1 **(1)**
(b)	$P(X \leq 2.4) = (2.4 - -4) \times \frac{1}{10}$	M1
	$= 0.64$ or $\frac{16}{25}$	A1
		(2)
(c)	$P(-3 < X - 5 < 3) = P(2 < X < 6)$	M1
	$= 0.4$	A1
		(2)
(d)	$\int_a^{4a} \frac{y^2}{4a-a} dy = \left[\frac{y^3}{9a}\right]_a^{4a}$	M1
		M1 dep
	$= \frac{64a^3 - a^3}{9a}$	A1
	$= 7a^2$ *AG	A1cso
		(4)
(e)	$\text{Var}(Y) = \frac{1}{12}(4a-a)^2$ or $\text{Var}(Y) = 7a^2 - \left(\frac{5}{2}a\right)^2$	M1
	$= \frac{3}{4}a^2$	A1cso
		(2)
(f)	$\frac{2}{3} = \frac{1}{3a}\left(\frac{8}{3} - a\right)$	M1
		A1
	$a = \frac{8}{9}$	A1
		(3)
		Total 14

Notes

(b) M1 $(2.4 - -4) \times \frac{1}{10}$ or $1 - (6 - 2.4) \times \frac{1}{10}$ o.e

(c) M1 finding $P(2 < X < 6)$ or $P(X > 2)$ or $1 - P(X < 2)$. May be implied by a correct answer if there is no incorrect working. Do not ignore subsequent incorrect working.
NB if they change the distribution to U[-9,1] then M1 is for finding $P(-3 < X < 1)$ or $P(X > -3)$ or $1 - P(X < -3)$. May be implied by a correct answer if there is no incorrect working. Do not ignore subsequent incorrect working.

(d) **NB remember the answer is given (AG) so they must show their working**

1st M1 writing or using $\int_a^{4a} y^2 f(y) dy$ with correct limits used at some point. Condone omission of dy. f(y) does not need to be correct.

2nd M1 dependent on previous M being awarded. Attempting to integrate at $y^n \rightarrow \frac{y^{n+1}}{n+1}$

1st A1 correct expression - the correct limits must be substituted.

2nd A1 cso

(e) (f)	M1 either use of $\frac{(b-a)^2}{12}$ or $E(Y^2) - [E(Y)]^2$:- they may use their part (d) for $E(Y^2)$ M1 using $\frac{1}{3a}\left(\frac{8}{3} - a\right)$ = a probability **or** $\frac{1}{3a}\left(4a - \frac{8}{3}\right)$ = a probability An answer of $\frac{8}{9}$ **with no incorrect working gains M1A1A1**	

Question Number	Scheme	Marks
5(a)	$P(T > t) = \dfrac{225}{(t+15)^2}$ $P(T \leq t) = 1 - P(T > t)$ $= 1 - \dfrac{225}{(t+15)^2}$ $F(t) = \begin{cases} 1-\dfrac{225}{(t+15)^2} & t \geq 0 \\ 0 & \text{otherwise.} \end{cases}$	B1 **(1)**
(b)	$P(T < 3) = 1 - \dfrac{225}{(3+15)^2}$ $= \dfrac{11}{36}$ or 0.30555… awrt 0.306	M1 A1 **(2)**
(c)	$P(T > 8 \mid T > 3) = \dfrac{P(T > 8)}{P(T > 3)}$ $= \dfrac{\frac{225}{23^2}}{\frac{225}{18^2}}$ $= \dfrac{324}{529}$ or 0.612.. awrt 0.612 / 0.6125	M1 M1 A1 **(3)**
(d)	$1 - F(t) = 0.1$ $\dfrac{225}{(t+15)^2} = 0.1$ or $1-\dfrac{225}{(t+15)^2} = 0.9$ $\dfrac{225}{0.1} = (t+15)^2$ $t = \sqrt{\dfrac{225}{0.1}} - 15$ t =32.4, also accept 32/33	M1 A1 M1 A1 **(4)** **Total 10**

Notes

(a) B1 The line $P(T \leq t) = 1 - P(T > t)$ or $F(t) = 1 - P(T > t)$ or both of the following statements $P(T > t) = \frac{225}{(t+15)^2}$ and $P(T \leq t)$ /$F(t) = 1 - \frac{225}{(t+15)^2}$ must be seen and no errors. Allow equivalent in words.
Condone use of < instead of ≤ or > instead of ≥ and vice versa.
The cdf must be given. Allow $t > 0$

(b) M1 substituting 3 into $F(t)$

(c) 1st M1 The conditional probability must,

- be a quotient and
- have $P(T > 3)$ or 'their numerical equivalent' for the denominator and
- have $P(T > 8)$ or $P(T > 5)$ or $P(T > 8 \cap T > 3)$ or $P(T > 5 \cap T > 3)$ or 'their numerical equivalent' for the numerator.

Allow ≥ in place of >

2nd M1 writing or using $P(T > 8)$ or $P(T \geq 8)$.
NB This is independent of the first M mark.

(d) 1st M1 writing or using $1 - F(t) = 0.1$ or $P(T \geq t) = 0.1$ May be implied by $\frac{225}{(t+15)^2} = 0.1$ o.e.

2nd M1 either square rooting or solving a quadratic either by factorising / completing the square / using the formula - must be correct for their quadratic.

A1 awrt 32.4 or 32 or 33. Do not accept $15\sqrt{10} - 15$

Question Number	Scheme	Marks
6(a)	A statement concerning a **population parameter**	B1
(b)	A critical region is the range / set of values / answers **or** a test statistic **or** region/area **or** values (where the test is significant)	B1
	that would lead to the rejection of H0 / acceptance of H_1	B1
		(3)
(c)	$H_0 : p = 0.45$ $H_1 : p < 0.45$ (or $p \neq 0.45$)	
	$X \sim B(20, 0.45)$	M1
	$P(X \leq 5) = 0.0553$ CR $X \leq 4$	A1
	Accept H_0. Not significant. 5 does not lie in the Critical region.	M1d
	There is no evidence that the proportion who voted for Mrs George is not 45% or there is evidence to support Mrs George's claim	A1cso
		(4)
(d)	B(8, 0.45): P(0) = 0.0084	M1
	B(7, 0.45): P(0) = 0.0152	A1
	Hence smallest value of n is **8**	B1
		(3)
	Alternative	
	$(0.55)^n < 0.01$	M1
	$n\log 0.55 < \log 0.01$	
	$n > 7.7\ldots$	A1
	Hence smallest value of n is **8**	B1cso
	Notes	**Total 10**
(a)	It must be a statement including the words **population parameter**.	
(c)	1st M1 using B(20, 0.45) and finding $P(X \leq 5)$ or $P(X \geq 6)$ Using the normal approximation to the binomial is M0 A1 0.0553 (allow 0.9447) if not using CR or CR $X \leq 4$ or $X < 5$ 2nd M1 dependent on previous M being awarded. A correct statement (do not allow if there are contradicting non contextual statements **nor** award if 2 probabilities are given which would result in different conclusions) A1cso Conclusion must contain the words **Mrs George**. There must be no incorrect working seen. If there are no hypotheses you cannot award this mark. **NB** A correct contextual statement on it's own will score M1 A1.	
(d)	M1 Attempt to find P(0) from B(n, 0.45) or $(0.55)^n < 0.01$ or $(0.55)^n = 0.01$ or $(0.55)^n > 0.01$ A1 P(0) = 0.0084 and P(0) = 0.0152 or getting 7.7 May be implied by correct answer. B1 cso. $n = 8$ should not come from incorrect working. NB An answer of 8 on its own with no working gains M1A1B1	

Question Number	Scheme	Marks
7(a)	$\int_0^5 a+bx \, \mathrm{d}x = 1$	M1
	$\left[ax + \frac{bx^2}{2}\right]_0^5 = 1$	A1
	$5a + \frac{25b}{2} = 1$	M1dep
	$10a + 25b = 2$	A1cso
		(4)
(b)	$\int_0^5 ax + bx^2 \, \mathrm{d}x = \frac{35}{12}$	M1
	$\left[\frac{ax^2}{2} + \frac{bx^3}{3}\right]_0^5 = \frac{35}{12}$	A1
	$\frac{25a}{2} + \frac{125b}{3} = \frac{35}{12}$	A1
	$30a + 100b = 7$	**(3)**
(c)	$30a + 100b = 7$ $10a + 25b = 2$	M1
	$a = 0.1 \quad b = 0.04$	A1,A1
		(3)
(d)	$\int_0^m 0.1 + 0.04x \, \mathrm{d}x = 0.5$	M1
	$\left[0.1x + \frac{0.04x^2}{2}\right]_0^m = 0.5$	A1ft
	$0.1m + 0.02m^2 - 0.5 = 0$	
	$m = \frac{-0.1 \pm \sqrt{0.1^2 + 4 \times 0.02 \times 0.5}}{2 \times 0.02}$	
	$m = 3.09$, -8.09 therefore 3.09	A1
		(3)
(e)	mean < median (< mode)	B1ft
	negatively skewed	B1 dep ft
		(2)
		Toal 15

Notes

(a)
1st M1 Attempting to integrate with correct limits or for an attempt to find area $0.5(a + b)h$ or Attempting to integrate and using F(5) = 1
1st A1 Correct integration or correct area
2nd M1 for using =1. This is dependent on the first M1 being awarded.
2nd A1 cso condone missing dx

(b)
M1 using or writing (limits not needed) $\int_0^5 ax + bx^2 \, \mathrm{d}x = \frac{35}{12}$
1st A1 correct integration
2nd A1 may be awarded for an unsimplified version $\frac{25a}{2} + \frac{125b}{3} = \frac{35}{12}$

(c)	M1 attempting to solve "their equations" simultaneously – either using rearranging and substitution **or** making one of the coefficients the 'same' (ignore sign) and either adding or subtracting. May be implied by correct values for *a* and *b* 1st A1 for 0.1 2nd A1 for 0.04
(d)	M1 writing or using $\int_0^m "their\ a" + "their\ b"\, x\, \mathrm{d}x = 0.5$: limits not needed 1st A1 correct integration for their "*a*" and "*b*" **NB** the correct equation simplifies to $m^2 + m - 25 = 0$ A1 3.09 only. If they have both roots then they must select 3.09
(e)	1st B1ft. They must compare their values for mean and median correctly. They only need to compare 2 of mean, median and mode. If they compare either the median or mean with the **mode only** then the value of the mode must be stated. They may draw a sketch that matches their values of '*a*' and '*b*' for $0 \leq x \leq 5$. It must not go below the *x*-axis This may be seen in part (a). 2nd B1 dependent f.t. on the previous B being awarded.

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