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Mark Scheme (Results)

Summer 2012

GCE Statistics S2
(6684) Paper 1

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Summer 2012
6684 Statistics 2
S2 Mark Scheme

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.

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 and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol √ 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.

Summer 2012
6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
1(a)	P(L>24) = $\frac{1}{15}\times 6$	M1
	= $\frac{2}{5}$ or 0.4 oe	A1 (2)
(b)	Let X represent the number of sweets with $L > 24$	
	X~B(20, 0.4)	M1
	P($X \geq 8$) = 1 – P($X \leq 7$)	M1dep
	= 1 – 0.4159	
	= 0.5841 awrt 0.584	A1 (3)
(c)	P(both $X \geq 8$) = $(0.5841)^2$	M1
	= 0.341…	A1 ft (2)
		Total 7

notes

1(a) M1 $\frac{1}{15}\times$(6 or 5.5 or 6.5 or (30 – 24)) or 1 - $\frac{1}{15}$ ((24 – 15) or (23.5 – 15) or (24.5 – 15))

(b) M1 using B(20, "their (a))

M1 dependent on 1st M1. Writing or use of 1 – P($X \leq 7$)

NB Use of normal/normal approximation/ Poisson/uniform gets M0 M0 A0

(c) M1 (their(b))^2 or $(0.58)^2$ or $(0.5841)^2$ or $(0.584)^2$

A1ft –either awrt 0.34 or follow through their answer to part (b) must be to 2sf or better.

Note you will have to check this.

Question Number	Scheme	Marks
2.(a)	$X \sim B(25,0.5)$ may be implied by calculations in part a or b	M1
	$P(X \leq 7) = 0.0216$	
	$P(X \geq 18) = 0.0216$	
	CR $X \leq 7; \cup X \geq 18$	A1,A1 (3)
(b)	P(rejecting H_0) = 0.0216 + 0.0216	M1
	= 0.0432 awrt 0.0432/0.0433	A1 (2)
		Total 5

Notes

2(a) M1 - Using B(25,0.5) – may be implied by a correct critical region or by calculations in part a or b
Note Just seeing either $P(X \leq 7)$ or $P(X \geq 18)$ scores M1 A0 A0.
You may need to check their probabilities in the tables for values other than 7 or 18.
1st A1 – also allow $X < 8$ or $[0,7]$ or $0 \leq X \leq 7$ or $0 \leq X < 8$ oe e.g. [0, 8) or a full list
DO NOT allow CRs given as $P(X \leq 7)$ or 7 – 0 for the A mark.
2nd A1 – also allow $X > 17$ or $[18,25]$ or $18 \leq X \leq 25$ or $17 < X \leq 25$ oe e.g. (17, 25] or a full list
DO NOT allow CRs given as $P(X \geq 18)$ or 18 - 25 for the A mark.
SC $7 \geq X \geq 18$ gains M1 A1 A0.

(b) M1 – adding their two critical regions' probabilities together or may be awarded for awrt 0.0432
If they add their critical regions' probabilities and then go on and get a different probability as their answer then it is M0A0
e.g. 0.0216 + 0.0216 = 0.0432 then 0.05 – 0.0432 = 0.0068 gets M0 A0
e.g. 0.0216 + 0.0216 = 0.0432 < 0.05 reject H_0 gets M1 A1
e.g. 0.0216 + 0.0216 = 0.0432 so probability of rejecting H_0 is 1 – 0.0432 = 0.9568 gets M0 A0

Question Number	Scheme	Marks
3(a)	n – large/high/big/ n >50	B1
	p – small/close to 0 / p < 0.2	B1
		(2)
(b)	$H_0 : p = 0.03$ $H_1 : p > 0.03$	B1,B1
	Po(6)	B1
	$P(X \geq 12) = 1 - P(X \leq 11)$ or $P(X \leq 10) = 0.9574$	M1
	$= 1 - 0.9799$ $P(X \geq 11) = 0.0426$	
	$= 0.0201$ CR $X \geq 11$	A1
	(0.0201 < 0.05)	
	Reject H_0 or Significant or 12 lies in the Critical region.	M1 dep.
	There is evidence that the proportion of defective bolts has increased.	A1 ft
		(7)
		Total 9

(b) Notes

1st B1 for $H_0 : p = 0.03$

2nd B1 for $H_1 : p > 0.03$

SC If both hypotheses are correct but a different letter to p is used they get B1 B0

Also allow B1 B0 for $H_0 : \lambda = 6$ and $H_1 : \lambda > 6$

B1 writing or using Po(6)

<u>One tail</u>

1st M1 for writing or using 1 - $P(X \leq 11)$ or giving $P(X \leq 10) = 0.9574$ or giving $P(X \geq 11) = 0.0426$. May be implied by correct CR or probability = 0.0201

1st A1 for 0.0201 or CR $X \geq 11$/ $X > 10$. **NB** $P(X \leq 11) = 0.9799$ on its own scores M1A1

2nd M1 dependent on the 1st M1 being awarded. For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "significant" and "accept H_0". **Ignore comparisons**.

2nd A1 ft for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.05 < p < 0.95$	$p < 0.05$ or $p > 0.95$
2nd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>not increased/is not higher/oe</u>**	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>increased/is higher/oe</u>**

<u>Two tail</u>

1st M1 for writing or using 1 - $P(X \leq 11)$ or giving $P(X \geq 12) = 0.0201$ or giving $P(X \leq 11) = 0.9799$. May be implied by correct CR or probability = 0.0201

1st A1 for 0.0201 or CR $X \geq 12$/ $X > 11$. **NB** $P(X \leq 11) = 0.9799$ on its own scores M1A1

2nd M1 dependent on the 1st M1 being awarded. For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "significant" and "accept H_0". **Ignore comparisons**.

2nd A1 ft for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.025 < p < 0.975$	$p < 0.025$ or $p > 0.975$
2nd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>not increased/is not higher/oe</u>**	The **<u>proportion/number/amount/percentage oe</u>** of **<u>defective bolts</u>** has **<u>increased/is higher/oe</u>**

Use of N(6,5.82) May get B1 B1 B0 M1 (must use 11.5)A0 M1dep A1 ft

Question Number	Scheme	Marks
4(a)	Let X be the random variable the number of houses sold.	
	$X \sim$Po(8)	B1
(i)	$P(X \leq 3) - P(X \leq 2) = 0.0424 - 0.0138$ or $\frac{e^{-8}8^3}{3!}$	M1
	$= 0.0286$ awrt 0.0286	A1
(ii)	$P(X > 5) = 1 - P(X \leq 5)$	M1
	$= 1 - 0.1912$	
	$= 0.8088$ awrt 0.809	A1
		(5)
(b)	Let Y be the random variable = the number of periods where more than 5 houses are sold	
	$Y \sim$ B(12,0.8088)	M1
	$P(Y = 9) = (0.8088)^9(1 - 0.8088)^3 \frac{12!}{9!3!}$	M1
	$= 0.228$ awrt 0.228	A1
		(3)
(c)	N(20,20)	M1A1
	$P(X > 25) = 1 - P\left(Z \leq \frac{25.5 - 20}{\sqrt{20}}\right)$	M1,M1,A1
	$= 1 - P(Z \leq 1.23)$	
	$= 1 - 0.8907$	
	$= 0.1093 / 0.1094$ awrt 0.109	A1
		(6)
		Total 14

Notes

(a) 1st B1 for writing or using Po(8) in either (i) or (ii)

(i) M1 writing or using $P(X \leq 3) - P(X \leq 2)$ or $\frac{e^{-8}8^3}{3!}$

(ii) M1 writing or using $1 - P(X \leq 5)$

(b) M1 writing or attempting to use B(12,their (a(ii))) NB ft their a(ii) to at least 2sf

M1 $\frac{12!}{9!3!}$ (a(ii))^9(1- a(ii))^3 allow $^{12}C_3$ or $^{12}C_9$ or 220 instead of $\frac{12!}{9!3!}$ NB ft their a(ii) to at least 1sf but an expression must be seen (No use of tables)

(c) 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 [24.5, 25, 25.5, 26 or 26.5] and for finding correct area by doing 1 – P(Z≤ "their 1.23")

NB if they have not written down a mean and sd then they need to be correct in the standardisation to gain this mark.

3rd M1 for attempting a continuity correction (26 ± 0.5)

2nd A1 for $\pm\frac{25.5 - 20}{\sqrt{20}}$ or ± awrt 1.2 or better.

SC using P(X< 26.5/25.5) – P(X<25.5/24.5) can get M1A1 M0M1A0A0

Question Number	Scheme	Marks
5(a)	$\int_0^k \frac{3}{32}x(k-x)=1$	M1
	$\frac{3}{32}\left[\frac{kx^2}{2}-\frac{x^3}{3}\right]_0^k=1$	A1
	$\frac{3k^3}{64}-\frac{3k^3}{96}=1$	M1 dep
	$3k^3-2k^3=64$	
	$k^3=64$	
	$k=4$	A1cso
		(4)
b	[E(X) =] 2	B1
		(1)
c	$E(X^2)=\int_0^4 \frac{3}{32}x^3(4-x)$	M1
	$=\left[\frac{3x^4}{32}-\frac{3x^5}{160}\right]_0^4$	
	$=\left[\frac{3\times4^4}{32}-\frac{3\times4^5}{160}\right]$	
	= 4.8	A1
	Var (X) = 4.8 – 4	M1
	= 0.8	A1
		(4)
d	$\int_{1.5}^{2.5}\frac{3}{32}x(4-x)=\left[\frac{3x^2}{16}-\frac{x^3}{32}\right]_{1.5}^{2.5}$ or $\int_0^{1.5}\frac{3}{32}x(4-x)=\left[\frac{3x^2}{16}-\frac{x^3}{32}\right]_0^{1.5}$	M1
	$=\frac{47}{128}=0.3671875$ $\quad$ $=\frac{81}{256}=0.31640625$	
	$1-\frac{47}{128}=\frac{81}{128}$ awrt 0.633 $\quad$ $2\times\frac{81}{256}=\frac{81}{128}$ awrt 0.633	M1depA1
		(3)
		Total 12

Notes

(a)

1st M1 for an attempt to multiply out bracket and for attempting to integrate f(x). Both $x^n \rightarrow x^{n+1}$

1st A1 for correct integration. Ignore limits for these two marks. Need $\frac{3}{32}\left(\frac{kx^2}{2}-\frac{x^3}{3}\right)$ oe

2nd M1 Dependent on the previous M mark being awarded. For correct use of correct limits and set equal to 1. No need to see 0 substituted in. For verifying they must have $\frac{3}{32}\left(\frac{4^3}{2}-\frac{4^3}{3}\right)$

2nd A1 cso or for verifying $\frac{3}{32}\left(\frac{4^3}{2}-\frac{4^3}{3}\right)=1$ **oe** eg $3(4)^3-2(4)^3=64$ and a correct comment "so $k=4$"

(c)

1st M1 attempt to multiply out bracket and attempting $\int x^2 f(x)$ Limits not needed. Both $x^n \rightarrow x^{n+1}$

2nd M1 for their $E(X^2)$ – (their mean)^2

(d)

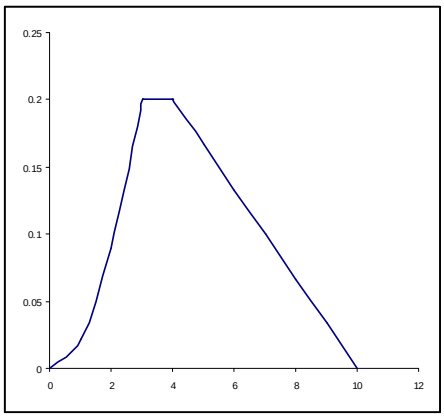
1st M1 Multiply out brackets, attempting to integrate (both $x^n \rightarrow x^{n+1}$), with either limits (their(b) ± 0.5) or (their (b) – 0.5 and 0) Accept 2 sf for their limits.

2nd M1dep on gaining 1st M1. 1 – (using limits (their(b) ±0.5)) or 2 × (using limits (their(b) – 0.5 and 0)

Question Number	Scheme	Marks
6	Attempt to write down combinations — at least one seen	**M1**
	(1,1,1), (1,1,2) any order (1,2,2) any order, (2,2,2) — no extra combinations	**A1**
	Range 0 and 1 — 0 and 1 only	**B1**
	[P(range = 0) =] $(0.65)^3 + (0.35)^3$ — either range	**M1**
	$= 0.3175$ or $\frac{127}{400}$	**A1cao**
	[P(range = 1) =] $(0.35)^2(0.65) \times 3 + (0.65)^2(0.35) \times 3$	
	$= 0.6825$ or $\frac{273}{400}$	**A1cao**
		(6)
		Total 6

Notes

First M1 may be implied by either $(0.65)^3$ or $(0.35)^3$or $(0.65)^2(0.35)$ or $(0.35)^2(0.65)$
First A1 may be implied by $(0.65)^3$ **and** $(0.35)^3$ **and** $(0.65)^2(0.35)$ **and** $(0.35)^2(0.65)$
No need for x3
2nd M1 $(p)^3 + (1-p)^3$ or $(1-p)^2(p) \times 3 + (p)^2(1-p) \times 3$
A1 for 0.3175 cao or exact equivalent e.g $\frac{254}{800}$
A1 for 0.6825 cao or exact equivalent e.g $\frac{546}{800}$
NB These probabilities do not need to be associated with the correct range

Question Number	Scheme	Marks
7(a)		**B1**
		B1
		B1
		B1dep
		0.2,3,4,10
		(4)
(b)	$F(x) = \begin{cases} 0 & x < 0 \\ \frac{x^3}{135} & 0 \le x \le 3 \\ \frac{x}{5} - \frac{2}{5} & 3 < x < 4 \\ \frac{x}{3} - \frac{x^2}{60} - \frac{2}{3} & 4 \le x \le 10 \\ 1 & x > 10 \end{cases}$	**M1A1** **M1A1** **M1A1**
	1st M1 For $0 \le x \le 3$, $F(x) = \int_0^x \frac{t^2}{45} dt$ $= \left[\frac{t^3}{135}\right]_0^x$	
	2nd M1 For $3 < x < 4$, $F(x) = \int_3^x \frac{1}{5} dt + \frac{1}{5}$ $= \left[\frac{t}{5}\right]_3^x + \frac{1}{5}$ or $F(x) = \int \frac{1}{5} dx + C$ and uses $F(3) = \frac{1}{5}$ $\frac{1}{5} = \left[\frac{3}{5}\right] + C$	
	3rd M1 For $4 \le x \le 10$, $F(x) = \int_4^x \frac{1}{3} - \frac{x}{30} dt + \frac{2}{5}$ $F(x) = \left[\frac{t}{3} - \frac{t^2}{60}\right]_4^x + \frac{2}{5}$ or $F(x) = \int \frac{1}{3} - \frac{x}{30} dx + C$ and uses $F(4) = \frac{2}{5}$ or $F(10) = 1$ $\frac{2}{5} = \frac{4}{3} - \frac{4^2}{60} + C$ or $1 = \frac{10}{3} - \frac{10^2}{60} + C$	
	Top line of $F(x)$ ie 0 $x < 0$ Bottom line of $F(x)$ ie 1 $x > 10$	**B1** **B1** **(8)**
(c)	$F(8) = \frac{8}{3} - \frac{8^2}{60} - \frac{2}{3}$ $= \frac{14}{15} = 0.933$	**M1** **A1 cso** **(2)** **Total 14**

	Notes	
(a)	1st B1 for a curve. It must start at (0, 0) and have the correct curvature. 2nd B1 for a horizontal line that joins the first section of the graph (not by a dotted line) 3rd B1 for a straight line with negative gradient that joins the horizontal line and stops on the positive x axis. 4th B1 dependent on first 3 marks being gained. Fully correct graph with labels 0.2, 3,4,10 in correct places	
(b)	For all the M marks, the attempt to integrate must have at least one $x^n \rightarrow x^{n+1}$ All A marks are for the correct expressions and ranges. Do not penalise the use of $\leq$ instead of $<$ and $\geq$ instead of $>$. **1st M1** for attempt to integrate $\int_0^x \frac{t^2}{45}\mathrm{d}t$ ignore limits **2nd M1** for attempt to integrate $\int_3^x \frac{1}{5}\mathrm{d}t + \text{their F(3)}$ using correct limits. **or** for attempt to integrate $\int \frac{1}{5}\mathrm{d}x + \mathrm{C}$ and substituting in 3 and putting = to their F(3) or substituting in 4 and putting = to their F(4) from their $4 \leq x \leq 10$ line **3rd M1** for attempt to integrate $\int_4^x \frac{1}{3} - \frac{x}{30}\mathrm{d}t + \text{their F(4)}$ using correct limits. **or** for attempt to integrate $\int \frac{1}{3} - \frac{x}{30}\mathrm{d}t + \mathrm{C}$ and substituting in 4 and putting = to their F(4) or substituting in 10 and putting = 1	
(c)	M1 substituting 8 into the 4th line of their cdf **or** F(3) + F(4) – F(3) + F(8) – F(4) or 1 - $\int_8^{10} \frac{1}{3} - \frac{x}{30}$ (attempt to integrate needed) or use areas e.g $1 - \frac{1}{2} \times 2 \times \frac{1}{15}$ or $1 - \frac{1}{15}$ A1 14/15 awrt 0.933 from correct working. NB If using F(3) + F(4) – F(3) + F(8) – F(4) then F(x) must be correct.	

Question Number	Scheme	Marks
8(a)	Let X be the random variable the number of customers asking for water.	
(i)	$X \sim B(10,0.6)$; $Y \sim B(10,0.4)$	B1
	$P(X = 6) = (0.6)^6(0.4)^4 \frac{10!}{6!4!}$; $P(Y = 4) = (0.4)^4(0.6)^6 \frac{10!}{6!4!}$	M1
	$= 0.2508\ldots$; $= 0.2508$; awrt 0.251	A1
(ii)	$X \sim B(10,0.6)$; $Y \sim B(10,0.4)$	
	$P(X < 9) = 1 - (P(X = 10) + P(X = 9))$ $= 1 - (0.6)^{10} - (0.6)^9(0.4)^1 \frac{10!}{9!1!}$; $P(X < 9) = 1 - P(Y \leq 1)$ $= 1 - 0.0464$	M1
	$= 0.9536\ldots$; $= 0.9536\ldots$; awrt 0.954	A1
		(5)
(b)	$X \sim B(50,0.6)$	M1
	$Y \sim B(50,0.4)$	
	$P(X < n) \geq 0.9$	
	$P(Y > 50 - n) \geq 0.9$ or $P(X < 34) = 0.8439$ awrt 0.844	
	$P(Y \leq 50 - n) \leq 0.1$ $P(X < 35) = 0.9045$ awrt 0.904/0.905	M1
	$50 - n \leq 15$	
	$n \geq 35$	
	$n = 35$	A1
		(3)
		Total 8

Notes

(a) B1 writing or using B(10,0.6) / B(10,0.4) in either part(i) or (ii)

(i) M1 $(0.6)^6(1-0.6)^4 \frac{10!}{6!4!}$ Allow ${}^{10}C_6$ oe

or writing or using $P(X \leq 6) - P(X \leq 5)$ if using B(10,0.6)

or $P(X \leq 4) - P(X \leq 3)$ if using B(10,0.4)

NB use of Poisson will gain M0A0

(ii) M1 writing or using $1 - (P(X = 10) + P(X = 9))$ if using B(10,0.6)

or

$1 - P(Y \leq 1)$ if using B(10,0.4)

NB use of Poisson will gain M0A0

(b) 1st M1 for writing or using either B(50,0.6) or B(50,0.4)

2nd M1 $P(Y > 50 - n) \geq 0.9$ or $P(Y \leq 50 - n) \leq 0.1$ or $P(X < 34)$ = awrt 0.844 or $P(X < 35)$ = awrt 0.904/0.905 or $50 - n = 15$ or $50 - n = 16$ or $50 - n \leq 15$ or $50 - n \leq 16$ – allow different letters

A1 cao 35. Do not accept $n \geq 35$ for final A1.

SC use of normal.

M1 M0 A0 for use of N(30,12) leading to an answer of 35

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