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Mark Scheme (Results)

June 2011

GCE Statistics S2 (6684) Paper 1

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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 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

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6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
1. **(a)**	The list of ID numbers	B1 (1)
(b)	$F \sim B(50,0.02)$	B1 B1 (2) **3**
Notes: (a)	B1 for idea of list/register/database and identity numbers NB B0 if referring to the sample or 50 or only part of the population.	
(b)	**These must be in part (b) to gain the marks** 1st B1 for Binomial distribution 2nd B1 for $n = 50$ and $p = 0.02$ or (50,0.02) NB (0.02, 50) is B0 Po(1) alone is B0B0 For a probability table 1st B1 Use of B(50,0.02) NB $P(X = 0) = 0.3642$ 2nd B1 Table must have all 50 values and their probabilities.	

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Question Number	Scheme	Marks
2. (a)	Poisson	B1 (1)
(b)	$H_0 : \mu = 9$ (or $\lambda = 36$) $H_1 : \mu > 9$ (or $\lambda > 36$) $X \sim$Po(9) and P($X \geq 12$) = 1 - P($X \leq 11$) = 1-0.8030 = 0.197 or P($X \leq 14$) = 0.9585, P($X \geq 15$) = 0.0415, CR X ≥ 15 (0.197 > 0.05) so not significant/ accept H_0/ Not in CR he does not have evidence to switch on the speed restrictions (o.e)	B1 B1 M1 A1 M1d A1ft (6)
(c)	Let Y = the number of vehicles in 10 s then $Y \sim$Po(6) Tables: P($Y \leq 10$) = 0.9574 so P($Y \geq 11$) = 0.0426 so needs 11 vehicles	B1 M1 A1 (3) **10**

Notes:

(a) B1 for Poisson or Po. Ignore their value for the mean.

(b) 1st B1 for $H_0 : \mu / \lambda = 9$ or $\mu / \lambda = 36$

2nd B1 for $H_1 : \mu / \lambda > 9$ or $\mu / \lambda > 36$

One tail

1st M1 for writing or using 1 - P($X \leq 11$) or writing P($X \leq 14$) = 0.9585 or P($X \geq 15$) = 0.0415. May be implied by correct CR.or probability = 0.197

A1 for 0.197 or a correct CR. Allow $X > 14$. NB P($X \leq 11$) = 0.8030 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 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	Insufficient evidence to switch on the speed restrictions	Sufficient evidence to switch on the speed restrictions

Two tail

1st M1 for writing or using 1 - P($X \leq 11$) or writing P($X \leq 15$) = 0.9780 or P($X \geq 16$) = 0.022. May be implied by correct CR. or probability = 0.197

A1 for 0.197 or CR $X \geq 16$. Allow $X > 15$. NB P($X \leq 11$) = 0.8030 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**

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Question Number	Scheme	Marks
	comparisons. 2nd A1 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	Insufficient evidence to switch on the speed restrictions	Sufficient evidence to switch on the speed restrictions

(c)	B1 for identifying Po(6) - may be implied by use of correct tables M1 any one of the probs 0.9574 or 0.0426 or 0.9799 or 0.0201 may be implied by correct answer of 11 A1 cao do not accept $X \geq 11$ NB answer of 11 with no working gains all three marks.	
3. (a)	Mode = 3 from graph	B1 (1)
(b)	$\int_0^3 kx^2 \, dx = 0.5 \Rightarrow \left[\frac{kx^3}{3}\right]_0^3 = 0.5$ So $\frac{27k}{3} - 0 = 0.5 \Rightarrow k = \frac{1}{18}$ (using median = 3)	M1 A1 M1d A1 (4)
(c)	Height of triangle = $\frac{1}{18} \times 3^2 = \frac{1}{2}$ Area of triangle = $\frac{1}{2} \times (a-3) \times \frac{1}{2} = \frac{1}{2}$ so $a = 5$ cao	B1ft M1 A1 (3)
(d)	From graph distribution is negative skew (left tail is longer) $\mu <$ median for negative skew so E(X) < 3 [N.B. E(X) = $2\frac{23}{24}$]	B1 B1d (2) **10**

Notes:

(b)
1st M1 for attempt to integrate f(x) (need x^3). Integration must be in part (b)
1st A1 for correct integration. Ignore limits for these two marks.
2nd M1 Dependent on the previous M mark being awarded. For use of correct limits and set equal to 0.5 - leading to a linear equation for k. No need to see 0 substituted.
2nd A1 for $k = \frac{1}{18}$ or exact equivalent
NB $k = \frac{1}{18}$ with no working gains M0A0M0A0
k = $\frac{1/2}{9} = \frac{1}{18}$ without sight of integration is M0A0M0A0

(c)
B1 for correct height of triangle using their k. ie $9k$. May be seen in working for area of triangle.
Or correct gradient of line ie $\frac{9k}{(3-a)}$ o.e.

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Question Number	Scheme	Marks
	M1 for a correct linear equation for a, in the form $\pm\frac{1}{2}\times(a-3)\times 9k=\frac{1}{2}$ (Must see the halves) NB if they have stated their height and then used their height rather than $9k$ allow M1 A1 cao NB stating a = 5 and then verifying area of the triangle = 0.5 is acceptable. NB a = 5 on its own is B0M0A0 SC Integration of both parts = 1 or Integration of line = 0.5 leading to $a^2-8a+15=0$ gets B1 M1 and if they identify a = 5 A1	
(d)	1st B1 for identifying negative skew 2nd B1 dependent on previous B mark being awarded. For correct deduction E(X) <3	
4 (a)	$\frac{9.5-7}{10-7}$ $=\frac{5}{6}$ awrt 0.833	M1 A1 (2)
(b)	P(Longest > 9.5) = 1 - P(all < 9.5) = $1-\left(\frac{5}{6}\right)^3$ $=\frac{91}{216}$ or 0.421	M1 A1 (2)
(c)	P(a stick < 7.6) = $\frac{0.6}{3}=0.2$ Let Y = number of sticks (out of 6) <7.6 then Y~B(6, 0.2) P(Y > 4) = 1 - P($Y\leq 4$) = 1 - 0.9984 = 0.0016 or $\frac{1}{625}$	B1 M1 M1 A1 (4) **8**
Notes: (a) (b) (c)	M1 for an expression for the probability e.g. $\int_7^{9.5}\frac{1}{3}\,dx$ M1 for $1-(a)^3$ **or** $(1-a)^3+3(1-a)^2a+3(1-a)a^2$ A1 awrt 0.421 B1 0.2 may be implied by at least one correct probability 1st M1 for writing or using B(6, p) may be implied by $np^x(1-p)^{6-x}$ using their p and $n\geq 1$ 2nd M1 for writing or using 1 – P($Y\leq 4$) or $np^5(1-p)+p^6$ (n is an integer > 1) A1 cao NB 0.0016 with no working gets B0M0M0A0	
5. **(a)**	X ~Po(5); P($X\leq 3$) = 0.2650	M1 A1 (2)

Question Number	Scheme	Marks
(b)	Let Y = the no.of planks with at most 3 defects, Y ~Binomial Y~B(6, 0.265) P($Y < 2$) = P($Y \leq 1$) $= \left[0.735^6 + 6\times 0.265\times 0.735^5\right]$ = 0.4987…. **awrt 0.499 or 0.498**	M1 A1ft M1 A1 A1 (5)
(c)	Let T = total number of defects on 6 planks, T ~Po(30) so $T \approx S$ ~Normal S~N(30, 30) P($T < 18$) = P($S < 17.5$) $= P\left(z < \frac{17.5-30}{\sqrt{30}}\right)$ = P(Z < - 2.28…) = 0.01123... **awrt 0.0112 or 0.0113**	M1 A1 M1 M1 A1 A1 (6) **13**

Notes:

(a)
M1 for identifying Po(5) - it should be clearly seen somewhere or implied
A1 for correct probability. Allow 0.265

(b)
1st M1 for writing or using the binomial - may be implied by use of $nq^x(1-q)^{6-x}$ with $n \geq 1$
1st A1ft for $n = 6$ and p = their (a) may be implied by $6p(1-p)^5$ or $(1-p)^6$
NB if they write B(6,(a)) they get M1 A1
2nd M1 for writing P($Y \leq 1$) **or** P($Y = 0$) + P($Y = 1$) **or** $(1-q)^6 + nq(1-q)^5$ with $n \geq 1$
2nd A1 $(1-p)^6 + 6p(1-p)^5$ where p = their (a)
3rd A1 for awrt 0.499
SC use of a probability in the tables – lose last two marks – could get M1A1M1 M0 A0

(c)
1st M1 for a normal approx
1st A1 for correct mean and sd
2nd M1 for use of continuity correction, either 17.5 or 18.5 or 42.5 or 41.5 seen
3rd M1 Standardising with their mean and their sd and 17.5 or 18 or 18.5 or 41.5 or 42 or 42.5
NB if they have not written down a mean and sd then they need to be correct in the standardisation to gain this mark.
2nd A1 for $z = \pm 2.28$ or better. May be awarded for $\pm\frac{17.5-30}{\sqrt{30}}$ [NB no continuity correction z = 2.19]
3rd A1 for awrt 0.0112 or 0.0113 [NB no approximation gives 0.00727…]
SC using P(X<18.5) – P(X<17.5) can get M1 A1 M1 M0A0A0

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Question Number	Scheme	Marks
6. **(a)**	$H_0 : p = 0.15$ $H_1 : p \neq 0.15$ $X \sim B(30, 0.15)$ $P(X \leq 1) = 0.0480$ or CR: $X = 0$ $(0.0480 > 0.025)$ not a significant result or do not reject H_0 or not in CR there is no evidence of a change in the proportion of customers buying an item from the display.	B1 B1 M1 A1 M1 A1ft (6)
(b)	$H_0 : p = 0.2$ $H_1 : p > 0.2$ Let S = the number who buy sandwiches, $S \sim B(120, 0.2)$, $S \approx W \sim N\left(24, \sqrt{19.2}^2\right)$ $P(S \geq 31) = P(W \geq 30.5)$ $= P\left(Z > \frac{30.5 - 24}{\sqrt{19.2}}\right)$ or $\frac{x - 0.5 - 24}{\sqrt{19.2}} = 1.2816$ $[= P(Z > 1.48..)]$ $= 1 - 0.9306$ $= 0.0694$ $x = 30.1$ < 0.10 so a significant result, there is evidence that more customers are purchasing sandwiches or the shopkeepers claim is correct.	B1 M1 A1 M1 M1 M1 A1 B1ft (8) **14**

Notes:

(a)

1st B1 for H_0 must use p 2nd B1 for H_1 must use p
1st M1 for writing or using B(30,0.15) – may be implied by correct CR
1st A1 0.0480 or $X = 0$. Allow $X \leq 0$. Ignore upper CR. NB Allow CR $X \leq 1$ if using one tail test.
2nd M1 A correct statement (see table below) Do not allow non-contextual conflicting statements eg"significant" and "accept H_0". **Ignore comparisons**
2nd A1 for a correct statement in context. For context we need idea of change/decrease in number of customers buying from display – may use different words. NB A correct contextual statement on its own scores M1A1

	Two tail $0.025 < p < 0.975$ **or** **One tail** $0.05 < p < 0.95$	**Two tail** $p < 0.025$ or $p > 0.975$ **or** **One tail** $p < 0.05$ or $p > 0.95$
2nd M1	not significant/ accept H_0/ Not in CR or contextual	significant/ reject H_0/ In CR or contextual
2nd A1	There is no evidence of a change/decrease in the proportion of customers buying an item from the display	There is evidence of a change/decrease in the proportion of customers buying an item from the display.

(b)

1st B1 both hypotheses correct – must use p.
1st M1 for a normal approx
1st A1 for correct mean and sd
2nd M1 for use of continuity correction, either 30.5 or 31.5 or $(x \pm 0.5)$ seen
3rd M1 standardising with their mean and their sd and 30.5, 31 or 31.5 or x or $(x \pm 0.5)$)
4th M1 for 1 - tables value or 1.2816
2nd A1 for awrt 0.069 or $x = 30.1$
2nd B1ft For a correct conclusion in context using their probability and 0.1 For context we need idea of more customers buying sandwiches – may use different words

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Question Number	Scheme	Marks

		One tail $0.1 < p < 0.9$ **or Two tail** $0.05 < p < 0.95$	**One tail** $p < 0.1$ or $p > 0.9$ **or Two tail** $p < 0.05$ or $p > 0.95$
	2^{nd} M1	not significant/ accept H_0/ Not in CR or contextual	significant/ reject H_0/ In CR or contextual
	2^{nd} A1	There is no evidence of an increase in the proportion of customers buying sandwiches	There is evidence of a change/increase in the proportion of customers buying sandwiches.

	SC using P(X<31.5) – P(X<30.5) can get B1M1 A1 M1 M1M0A0B0	
7 (a)	$\cap$ shape which does not go below the x-axis [condone missing patios] Graph must end at the points (1,0) and (5,0) and the points labelled at 1 and 5	B1 B1 (2)
(b)	E(X) = 3 (by symmetry)	B1 (1)
(c)	$\left[E(X^2)\right] = \int x^2 f(x)dx = \frac{3}{32}\int\left(6x^3 - x^4 - 5x^2\right)dx$ $= \frac{3}{32}\left[\frac{6x^4}{4} - \frac{x^5}{5} - \frac{5x^3}{3}\right]_1^5$ $= \frac{3}{32}\left(\left[\frac{6\times 625}{4} - 625 - \frac{625}{3}\right] - \left[\frac{6}{4} - \frac{1}{5} - \frac{5}{3}\right]\right) = 9.8$ **(*)**	M1 A1 M1 A1 cso (4)
(d)	s.d. = $\sqrt{9.8 - \mathrm{E}(X)^2}$, = 0.8944… **awrt 0.894**	M1 A1 (2)
(e)	F(1) = 0 $\Rightarrow \frac{1}{32}(a - 15 + 9 - 1) = 0$, leading to $\underline{a = 7}$	M1 A1 (2)
(f)	F(2.29) = 0.2449…, F(2.31) = 0.2515… Since F(q_1) = 0.25 and these values are either side of 0.25 then 2.29< q_1 < 2.31	M1 A1 A1 (3)
(g)	Since the distribution is symmetric q_3 =5-1.3 = $\underline{3.7}$ cao	B1 (1)
(h)	We know P(q_1 =2.3 < X < 3.7= q_3) = 0.5 so $k\sigma = 0.7$ so $k = \frac{0.7}{0.894...} = 0.7826..$ = **awrt 0.78**	M1 A1 (2) **17**

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Question Number	Scheme	Marks
Notes:		
(c)	This part is a "show that" therefore we need to see all the steps in the working 1st M1 for showing intention of doing $\int x^2 f(x)$ and attempt to multiply out bracket 1st A1 for correct integration, cao, ignore limits for this mark. 2nd M1 for use of correct limits. Need to see evidence of subst both 5 and 1. 2nd A1 for cso leading to 9.8. Do not ignore subsequent working for this final A mark.	
(d)	M1 for a correct expression for standard deviation, must include $\sqrt{...}$ A1 allow awrt 0.894, $\sqrt{0.8}$, $\frac{2\sqrt{5}}{5}$ oe	
(e)	M1 for a correct method to find *a*. e.g F(5) = 1 or $\int_1^5 f(x) = 1$	
(f)	M1 for an attempt at F(2.29) or F(2.31) or put F(x) = 0.25 (ft their value of *a*) 1st A1 for both values seen. awrt 0.245 and 0.252 find 3 solutions awrt 6.76/6.75, 2.305, -0.064 2nd A1 for comparison with 0.25 and stating Q_1 state only 2.30 in range and stating Q_1 lies between 2.29 and 2.31 lies between 2.29 and 2.31	
(h)	M1 For $k\sigma$ = awrt 0.7 A1 Allow awrt 0.78 NB a correct awrt 0.78 gains M1 A1	

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