

Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE in Statistics S2R (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.

PEARSON 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 $\sqrt{}$ 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)
- d... or dep dependent
- indep independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper or ag- answer given
- _ or d... 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.

Question	Scheme	Marks
1.	$H_0: p = 0.2$ $H_1: p < 0.2$	B1
	$[X \sim B(40, 0.2)]$ $P(X \le 3) = 0.0285$ or CR of $X \le 3$	M1A1
	[0.0285 < 0.05] significant, reject H ₀	M1dep
	There is evidence to support the supplier's <u>claim</u>	A1cso
	or The probability of a ball failing the bounce test is less than 0.2	
		(5)
	Notes	
	1 st B1 for both H_0 and H_1 must use p or π	
	1^{st} M1 for writing or using B(40, 0.2), may be implied by correct answer	
	1 st A1 awrt 0.0285 or CR of $X \le 3$ as their final answer	
	2 nd M1 dependent on the previous method mark being awarded. A correct state	ment (this
	may be contextual) comparing "their probability" and 0.05 (or comparing 3 with	n their
	critical region). Do not allow conflicting statements.	
	2 nd A1cso This is cso so can only be awarded for a fully correct solution. A corr	rect
	contextualised conclusion (to include the words underlined in bold)	

Question	Scheme	Marks
2. (a)	(i) $S \underline{is}$ a statistic, (ii) D is <u>not</u> a statistic, (iii) $F \underline{is}$ a statistic	B1, B1, B1
	$T = \mathbf{P}(10, 0, 4)$	(3) M1 A 1
(b)	$I \sim B(10, 0.4)$	
		(2)
(c)	P(2' 2' 2) or $P(552, 5 > 52, >5 > 52)$	M1
	$=0.6^2 \times 0.4$ =	
	$(0.25)^{2}(0.4) + 2 \times (0.25)(0.35)(0.4) + (0.35)^{2}(0.4)$	
	= 0.144	A1
		(2)
		(7)
	Notes	
(a)	B1 for each variable. Accept "yes, no, yes" o.e.	
(h)	M1 for binomial	
	A1 for $n = 10$ and $n = 0.4$	
	NB If they give 2 options then unless they select the correct one they gain MOA	0
(c)	M1 for identifying the correct possibilities 2' 2' 2 <u>or</u> 5 5 2 and 5 > 5 2 and > 5 \pm	5 5 2 and >5
	>5 2 or a correct probability statement. The possibilities must be in the correct of	order.
	Condone	
	$2 \times (5 > 52)$ or $2 \times (>552)$. Implied a correct answer.	
	A1 for 0.144 or exact equivalent e.g. $\frac{18}{100}$	
	125	

Question	Scheme	Mar	ks
3. (a)	$X \sim \text{Po}(9)$	M1A1	
(b)	$P(X > 7) = 1 - P(X \le 7)$ = [1-0.3239] = 0.6761	M1 A1	(2)
(c)	[Y = no. of accidents in a month] Y~Po(1.5) $P(Y \ge 1) = 1 - P(Y = 0)$ $= [1 - 0.2231] = 0.7769 (= 0.777 (3dp))^*$	B1 M1 A1cso	(2)
(d)	[A = no. of months with at least one accident] A ~ B(6, 0.777) $P(A = 4) = \binom{6}{4} (0.777)^4 (0.223)^2$	M1 M1	(3)
	= 0.2719 awrt 0.272	A1	(3) (10)
	Notes		
(a) (b)	M1for Poisson (accept Po). Condone P(9)A1for mean of 9M1for writing $1 - P(X \le 7)$. This may be implied by $1 - 0.3239$ or a correct aA1for awrt 0.676	answer	
(c)	B1 Po(1.5) written or used M1 writing or using $1-P(Y=0)$ or $1-P(Y \le 0)$ or $1-e^{-\lambda}$ [may not be Y] A1 for at least $(1-0.223)$ or better. No need for final comment.* answer give does not imply all three marks	ven so 0.	777
(d)	1 st M1 for identifying binomial with $n = 6$ and $p = 0.777$ or better. Condone use 0.223. May be implied by $(p)^4(1-p)^2 p = $ awrt 0.777 or awrt 0.223 2 nd M1 Must have ${}^6C_4 (0.777)^4(1-0.777)^2$ A1 for awrt 0.272	e of <i>p</i> =	

Question	Scheme	Marks
4. (a)		B1B1B1
		(3)
(b)	$Mode = 2 \qquad 0 1 4 x$	BI (1)
		(1)
(C)	Mean < mode, so negative skew	BI, dBI
(d)	4	(2)
	$3k \times 1 + \int \left(4kx - kx^2\right) \mathrm{d}x = 1$	M1, B1
	$3k + \left\lfloor 2kx^2 - \frac{kx}{3} \right\rfloor_1 \{=1\}$	M1
	$3k + (32k - \frac{64k}{2}) - (2k - \frac{k}{2}) - 1$	M1d
	$\begin{bmatrix} 3k + \begin{pmatrix} 32k \\ 3 \end{pmatrix} \begin{pmatrix} 2k \\ 3 \end{pmatrix}^{-1}$	WITG
	$12k = 1$ so $k = \frac{1}{12}$	A1
		(5)
(e)	Lower Quartile = 1	B1 (1)
(f)	P(1 < X < 2) - P(2 < X < 3) by symmetry	(1) M1
(1)	$\begin{bmatrix} 1 & (1 & (1 & (2)) - 1 & (2 & (1 & (3)) & (3 & (3 & (3 & (3 & (3 & (3 & $	
	So $P(X > 3) = 1 - 3k - \frac{36}{36} = \frac{36}{36}$	AI (2)
	Notos	(14)
(9)	INOLES 1 st B1 for horizontal line $y = 3k$ and $3k$ marked on y-axis	
(a)	2^{nd} B1 for correct shape for $1 < x < 4$, meeting x-axis at (4, 0) and not extendir	ng below x-
	axis. Must be a curve	0
	3^{rd} B1 for $x = 1$ marked and graphs meeting at the point $(1, 3k)$	
(b)	B1 for 2	1 1 4
(C)	1 B1 for a suitable reason which matches their mode. The mode must be a muse mean	imber. Must
	2^{nd} dB1 not ft, dependent on 1^{st} B1. Correct answer from correct value of	
	Mode.	
(d)	1 IVI1 10r all mpung the sum of both areas = 1, 1gnore limits B1 for $3k$ seen added to integral	
	2^{nd} M1 For some correct integration, at least one $kx^n \rightarrow kx^{n+1}$	
	3 rd M1d Dependent on 1 st M1 being awarded. For use of correct limits.	
	A1 for $k = \frac{1}{12}$	
(e)	B1 for 1	
(f)	M1 for identifying the symmetry. May be implied by $P(1 < x < 2) = \frac{11}{36}$ four	nd by any
	method	
	or writing down a correct equation (ft their k). e.g	
	$0.75 - 2 \times \frac{11}{36} \text{ or } \int_{3}^{4} kx (4-x) dx \text{ or } 1 - 3k - \frac{11}{36} - \int_{1}^{2} 4kx - kx^{2} \text{ with the}$	eir <i>k</i> subst in
	A1 for $\frac{5}{36}$ or exact equivalent	

Question	Scheme	Marks
5. (a)	$\mathbf{H}_{0}: \lambda = \frac{1}{8} \text{ (or } \lambda = 5 \text{)} \qquad \mathbf{H}_{1}: \lambda \neq \frac{1}{8} \text{ (or } \lambda \neq 5 \text{)} \qquad \text{allow } \lambda \text{ or } \mu$	B1
	$X \sim Po(5), P(X \le 1) = 0.0404 \text{ or } P(X \ge 10) = 0.0318 \text{ or } P(X \ge 9) = 0.0681$ Critical Regions: $X \le 1$ or $X \ge 10$	M1 A1, A1
(b)	0.0404 + 0.0318 = 0.0722 (or 7.22% significance level)	M1A1 (2)
(c)	$H_0: \lambda = \frac{1}{8} \text{ (or } \lambda = 25 \text{)} \qquad H_1: \lambda < \frac{1}{8} \text{ (or } \lambda < 25 \text{)} \qquad \text{allow } \lambda \text{ or } \mu$	B1
	[Y= no. of defects in 200m of wallpaper] Y~Po(25) $Y \approx N(25, \sqrt{25}^2)$	M1A1
	P(Y ≤ 19) ≈ P $\left(Z < \frac{19.5 - 25}{\sqrt{25}}\right)$ or $\pm \frac{x - 0.5 - 25}{5} = 1.96$	M1M1
	= [P(Z < -1.1)] = 0.1357 (or 0.13566 from calc) x = 35.3	A1
	[> 0.05] not significant, there is insufficient evidence to support Thomas '	Alcso
	Or The number/rate/amount of defects is not decreased/less/reduced	(7) (13)
	Notes	
(a) (b)	M1 for suitable hypotheses M1 for correct use of Po(5). Award if one relevant probability is seen or a c Allow if a correct CR written as a Probability statement $1^{st} A1$ for $X \le 1$ or $X < 2$ or $0 < X < 2$ or $0 \le X < 2$ or $0 < X \le 1$ oe. Allow any le $2^{nd} A1$ for $X \ge 10$ or $X > 9$ or $10 \le x \le 40$ or $9 < x \le 40$ oe. Allow any letter Ignore any \cup or \cap signs Do not allow CR written as probability statements M1 for adding their probabilities of 'their' critical regions if sum gives a pr less than 1 or award if a correct answer given A1 for awrt 0.0722 (o.e)	orrect CR. etter robability
(c)	B1 for suitable hypotheses 1 st M1 for normal approximation 1 st A1 for mean =25 and variance = 25 or sd = 5 may be seen in the standardia or implied by a correct answer 2 nd M1 for attempting a continuity correction (Method 1:19 ± 0.5 / Method 2: <i>x</i> 3 rd M1 for standardising using their mean and their standard deviation and using Method 1 [19.5, 19, 18.5 accept ± <i>z</i> .] Method 2 [($x \pm 0.5$) and equal to a ± 2 2 nd A1 for awrt 0.136 or 35.3 or -1.1 > -1.96 3 rd A1 for a correct contextualised conclusion. cao for a one tailed test, must of correct working . Condone incorrect hypotheses. NB if finding P(<i>X</i> =19) ie P(<i>X</i> ≤ 19.5) - P(<i>X</i> ≤ 18.5)they can get B1 M1 A1M1 2	tion formula \pm 0.5) g either z value] come from M1 A0 A0

Question	Scheme	Marks
6. (a)	$\frac{d^2}{d^4} - \frac{d^4}{d^4} = \frac{1}{d^4}$	M1
	2 16 2	
	$\left[d^4 - 8d^2 + 8 = 0 \Longrightarrow\right] 8 = \left(d^2 - 4\right)^2 \text{ or } d^2 = \frac{8 \pm \sqrt{64 - 32}}{2}$	M1
	$d^2 = 4 - \sqrt{8}$	M1d
	$d = \sqrt{4 - \sqrt{8}} = 1.08239$ awrt 1.08	A1 (4)
(b)	$f(d) = d - \frac{d^3}{4}$	M1
	$\left[\mathbf{f}'(d) = 0 \Longrightarrow\right] 1 - \frac{3d^2}{4} = 0$	M1A1
	$\left[d^2 = \frac{4}{3} \text{ so}\right]d = 1.154$	A1
	$f''(d) = -\frac{6d}{4} < 0 \text{ so max}$	B1 (5)
(c)	$P(D < 1) = \left[\frac{1}{2} - \frac{1}{16}\right] = \frac{7}{16}$	B1
	Number of children = $80 \times \frac{7}{16}$, = 35	M1, A1
	10	(3) (12)
	Notes	
(a)	1 st M1 for forming this equation based on $F(d) = 0.5$ oe	
	2 ¹¹ M1 for attempting to solve (complete the square or use formula) –must be c	correct for
	$d3^{rd}$ M1 for square rooting to get $d = \dots$ Do not award for $d = awrt1.17$ Depe	endent on
	previous M being awarded.	
	A1 for awrt 1.08 Must reject any negative answers	
(b)	1 st M1 for attempting to find f(<i>d</i>). Some correct differentiation. $x^n \rightarrow x^{n-1}$ 2 nd M1 for attempting f'(<i>d</i>) and setting it =0 Some correct differentiation x^n to x^{n-1} 1 st A1 for a correct equation for <i>d</i>	x ⁿ⁺¹
	2 nd A1 for awrt 1.15 or 1.155 or $\sqrt{\frac{4}{3}}$ or $\frac{2\sqrt{3}}{3}$ or $\frac{2}{\sqrt{3}}$ oe	
	B1 for a method confirming that their value gives a max not a min	
ര	M1 for $80 \times n$ $0 < n < 1$	
	A1 for 35 only	

Question	Scheme	Mark	ζS
7. (a)	<i>X</i> ~ U[0, 9]	B1	
(b)	$[P(X > 6) =] \frac{1}{3}$ oe allow awrt 0.333	B1	(1)
(c)	$R = X(9-X), = 9X - X^2$	M1, A1	(1)
(d)	E(X) = 4.5	B1	(2)
	Var(X) = $\frac{81}{12} = \frac{27}{4}$ or $E(X^2) = \int_0^9 \frac{x^2}{9} dx$	B1	
	$E(X^{2}) = Var(X) + [E(X)]^{2} or \qquad = \left[\frac{x^{3}}{27}\right]_{0}^{9}$	M1	
	$E(X^2) = 27$	A1	
	So $E(R) = 9 \times 4.5 - 27 = 13.5$	dM1A1	
	Alternative method		(6)
	$\frac{\text{Alternative method}}{\int_{0}^{9} \frac{(9x - x^{2})}{9} \mathrm{d}x} = \left[\frac{9x^{2}}{18} - \frac{x^{3}}{27}\right]_{0}^{9}$	B1 B1 M1A1	
	$=\frac{81}{-81}$	dM1	
	$= 13.5^{2}$ 3	A1	
(e)	$R > 2X^2$ or $9X - X^2 > 2X^2$	M1	
	$9X > 3X^2$	A1	
	$\frac{50}{1}$	IVI 1	
	$=\frac{1}{3}$	A1	
		((4) (14)

	Notes
(a)	B1 for <i>X</i> ~U[0, 9] or "continuous uniform"/"rectangular" distribution with correct range
	Or allow the pdf f (x) = $\begin{cases} \frac{1}{9} & 0 \le x \le 9\\ 0 & \text{otherwise} \end{cases}$
(c)	M1 for $X(9-X)$ or $9X - X^2$ may be implied by a correct answer A1 for $9X - X^2$ or $a = -1$ and $b = 9$
(d)	1 st B1 for 4.5 or may be implied 2 nd B1 for $\frac{81}{12}or\frac{27}{4}$ or $\int_{0}^{9}\frac{x^{2}}{9}$ ignore limits 1 st M1 for full method for $E(X^{2})$ using their Var (X) and $E(X)$ or attempt to integrate $x^{n} \rightarrow x^{n+1}$ leading to a value for $E(X^{2})$. Need to be using $\int_{0}^{9}\frac{x^{2}}{9}$ ignore limits. 1 st A1 for $E(X^{2})=27$, may be implied. d2 nd M1 for using 9E(X) – $E(X^{2})$. With their $E(X)$ and $E(X^{2})$. This may be implied by a correct answer. Dep on first M
	Alternative B1 $\int_{0}^{9} \frac{(9x - x^{2})}{9} dx$ ignore limits, ft their (c) which must be of the form $aX^{2} + b$ B1 $\int_{0}^{9} \frac{(9x - x^{2})}{9} dx$ with correct limits, ft their (c) M1 attempt to integrate at least one $x^{n} \rightarrow x^{n+1}$. Need to be using their $\int_{0}^{9} \frac{(9x - x^{2})}{9} dx$ condone limits missing A1 Correct Integration dM1 subst in limits, need to see 9 substituted. Condone missing 0
(e)	Allow \leq instead of $<$ and \geq instead of $>$ in this part 1 st M1 for forming a suitable inequality in <i>R</i> and <i>X</i> or just <i>X</i> . May be implied by a correct probability in <i>X</i> . 1 st A1 for simplifying to $9X > 3X^2$ or $3 > X$. May be implied by a correct probability in <i>X</i> 2 nd M1 for forming a correct probability in <i>X</i> 2 nd A1 for $\frac{1}{3}$ or exact equivalent

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