PMT

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 $\surd$ 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)
   - d… or dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper or ag- answer given
   - $\lfloor$ 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.

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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.

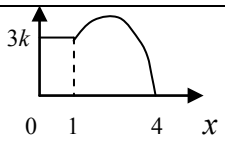
6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

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

Question	Scheme	Marks
2. (a)	(i) S is a statistic, (ii) D is not a statistic , (iii) F is a statistic	B1, B1, B1 (3)
(b)	$T \sim \mathrm{B}(10, 0.4)$	M1A1 (2)
(c)	P(2′ 2′ 2) or P(5 5 2, 5 >5 2, >5 >5 2) $=0.6^2 \times 0.4$ = $(0.25)^2(0.4)+2\times(0.25)(0.35)(0.4)+(0.35)^2(0.4)$ $=0.144$	M1 A1 (2) **(7)**
	Notes	
(a)	B1 for each variable. Accept "yes, no, yes" o.e.	
(b)	M1 for binomial A1 for $n = 10$ and $p = 0.4$ NB If they give 2 options then unless they select the correct one they gain M0A0	
(c)	M1 for identifying the correct possibilities 2′ 2′ 2 **or** 5 5 2 and 5 >5 2 and >5 5 2 and >5 >5 2 **or** a correct probability statement. The possibilities must be in the correct order. Condone $2\times$ (5 >5 2) or $2\times$ (>5 5 2). Implied a correct answer. A1 for 0.144 or exact equivalent e.g. $\frac{18}{125}$	

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

Question	Scheme	Marks
4. (a)		B1B1B1 (3)
(b)	Mode = 2	B1 (1)
(c)	Mean < mode, so negative skew	B1, dB1 (2)
(d)	$3k \times 1 + \int_1^4 \left(4kx - kx^2\right)\,\mathrm{d}x = 1$	M1, B1
	$3k + \left[2kx^2 - \frac{kx^3}{3}\right]_1^4 \{=1\}$	M1
	$3k + \left(32k - \frac{64k}{3}\right) - \left(2k - \frac{k}{3}\right) = 1$	M1d
	$12k = 1$ so $k = \frac{1}{12}$	A1 (5)
(e)	Lower Quartile = 1	B1 (1)
(f)	P($1 < X < 2$) = P($2 < X < 3$) by symmetry	M1
	So P($X > 3$) = $1 - 3k - \frac{22}{36} = \frac{5}{36}$	A1 (2)
		(14)

Notes

(a) 1st B1 for horizontal line $y = 3k$ and $3k$ marked on y-axis
2nd B1 for correct shape for $1 < x < 4$, meeting x-axis at (4, 0) and not extending below x-axis. Must be a curve
3rd B1 for $x = 1$ marked and graphs meeting at the point $(1, 3k)$

(b) B1 for 2

(c) 1st B1 for a suitable reason which matches their mode. The mode must be a number. Must use mean.
2nd dB1 not ft, dependent on 1st B1. Correct answer from correct value of Mode.

(d) 1st M1 for attempting the sum of both areas = 1, ignore limits
B1 for $3k$ seen added to integral
2nd M1 For some correct integration, at least one $kx^n \rightarrow kx^{n+1}$
3rd M1d Dependent on 1st 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($1 < x < 2$) = $\frac{11}{36}$ found by any method
or writing down a correct equation (ft their k). e.g
$0.75 - 2 \times \frac{11}{36}$ or $\int_3^4 kx(4 - x)\,\mathrm{d}x$ or $1 - 3k - \frac{11}{36} - \int_1^2 4kx - kx^2$ with their k subst in
A1 for $\frac{5}{36}$ or exact equivalent

Question	Scheme	Marks
5. (a)	$H_0 : \lambda = \frac{1}{8}$ (or λ=5) $H_1 : \lambda \neq \frac{1}{8}$ (or $\lambda \neq 5$) allow λ or μ	B1
	X~Po(5), P($X \leq 1$) = 0.0404 or P($X \geq 10$) = 0.0318 or P($X \geq 9$) = 0.0681	M1
	Critical Regions: $X \leq 1$ or $X \geq 10$	A1, A1 (4)
(b)	0.0404 + 0.0318 = 0.0722 (or 7.22% significance level)	M1A1 (2)
(c)	$H_0 : \lambda = \frac{1}{8}$ (or $\lambda = 25$) $H_1 : \lambda < \frac{1}{8}$ (or $\lambda < 25$) allow λ or μ	B1
	[Y= no. of defects in 200m of wallpaper] Y~Po(25) $Y \approx\sim N(25, \sqrt{25}^2)$	M1A1
	$P(Y \leq 19) \approx P\left(Z < \frac{19.5-25}{\sqrt{25}}\right)$ 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' claim.**	A1cso
	Or The **number/rate/amount** of **defects** is not **decreased/less/reduced**	(7) **(13)**

	Notes
(a)	B1 for suitable hypotheses M1 for correct use of Po(5). Award if one relevant probability is seen or a correct CR. Allow if a correct CR written as a Probability statement 1st A1 for $X \leq 1$ or $X < 2$ or $0 < X < 2$ or $0 \leq X < 2$ or $0 < X \leq 1$ oe. Allow any letter 2nd A1 for $X \geq 10$ or $X > 9$ or $10 \leq x \leq 40$ or $9 < x \leq 40$ oe. Allow any letter Ignore any $\cup$ or $\cap$ signs Do not allow CR written as probability statements
(b)	M1 for adding their probabilities of 'their' critical regions if sum gives a probability less than 1 or award if a correct answer given A1 for awrt 0.0722 (o.e)
(c)	B1 for suitable hypotheses 1st M1 for normal approximation 1st A1 for mean =25 and variance = 25 or sd = 5 may be seen in the standardiation formula or implied by a correct answer 2nd M1 for attempting a continuity correction (Method 1:19 $\pm$ 0.5 / Method 2:$x \pm 0.5$) 3rd M1 for standardising using their mean and their standard deviation and using either Method 1 [19.5, 19, 18.5 accept $\pm z$.] Method 2 [($x \pm 0.5$) and equal to a $\pm$ z value] 2nd A1 for awrt 0.136 or 35.3 or -1.1 > -1.96 3rd A1 for a correct contextualised conclusion. cao for a one tailed test, must come from correct working . Condone incorrect hypotheses. **NB** if finding P(X=19) ie P($X \leq 19.5$) - P($X \leq 18.5$)they can get B1 M1 A1M1 M1 A0 A0

Question	Scheme	Marks
6. (a)	$\frac{d^2}{2}-\frac{d^4}{16}=\frac{1}{2}$	M1
	$\left[d^4-8d^2+8=0\Rightarrow\right]8=\left(d^2-4\right)^2$ 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
	$\left[f'(d)=0\Rightarrow\right]\ 1-\frac{3d^2}{4}=0$	M1A1
	$\left[d^2=\frac{4}{3}\text{ so}\right]d=1.154...$	A1
	$f''(d)=-\frac{6d}{4}<0$ 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 (3) **(12)**

	Notes
(a)	1st M1 for forming this equation based on F(d) = 0.5 oe 2nd M1 for attempting to solve (complete the square or use formula) –must be correct for their equation d3rd M1 for square rooting to get d = …. Do not award for d = awrt1.17 Dependent on previous M being awarded. A1 for awrt 1.08 Must reject any negative answers
(b)	1st M1 for attempting to find f(d). Some correct differentiation. $x^n \rightarrow x^{n-1}$ 2nd M1 for attempting $f'(d)$ and setting it =0 Some correct differentiation x^n to x^{n+1} 1st A1 for a correct equation for d 2nd 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
(c)	M1 for $80\times p$, $0<p<1$ A1 for 35 only

Question	Scheme	Marks
7. (a)	$X \sim \text{U}[0, 9]$	B1 (1)
(b)	$[\text{P}(X > 6) =] \ \frac{1}{3}$ oe allow awrt 0.333	B1 (1)
(c)	$R = X(9 - X), \ = 9X - X^2$	M1, A1 (2)
(d)	$\text{E}(X) = 4.5$	B1
	$\text{Var}(X) = \frac{81}{12} = \frac{27}{4}$ **or** $\text{E}(X^2) = \int_0^9 \frac{x^2}{9}\,\text{d}x$	B1
	$\text{E}(X^2) = \text{Var}(X) + [\text{E}(X)]^2$ **or** $= \left[\frac{x^3}{27}\right]_0^9$	M1
	$\text{E}(X^2) = 27$	A1
	So $\text{E}(R) = 9 \times 4.5 - 27 = 13.5$	dM1A1 (6)
	Alternative method	
	$\int_0^9 \frac{(9x - x^2)}{9}\,\text{d}x = \left[\frac{9x^2}{18} - \frac{x^3}{27}\right]_0^9$	B1 B1 M1A1
	$= \frac{81}{2} - \frac{81}{3}$	dM1
	$= 13.5$	A1
(e)	$R > 2X^2$ or $9X - X^2 > 2X^2$	M1
	$9X > 3X^2$	A1
	So $\text{P}(X < 3)$	M1
	$= \frac{1}{3}$	A1 (4)
		(14)

	Notes	
(a)	B1 for X~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)	1st B1 for 4.5 or may be implied 2nd B1 for $\frac{81}{12} or \frac{27}{4}$ **or** $\int_0^9 \frac{x^2}{9}$ ignore limits 1st 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. 1st A1 for $E(X^2)$=27, may be implied. d2nd 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) whch 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 ≤ instead of < and ≥ instead of > in this part 1st M1 for forming a suitable inequality in R and X or just X. May be implied by a correct probability in X. 1st A1 for simplifying to $9X > 3X^2$ or $3 > X$. May be implied by a correct probability in X 2nd M1 for forming a correct probability in X 2nd A1 for $\frac{1}{3}$ or exact equivalent	

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