Mark Scheme (Results)

January 2016

Pearson Edexcel International A Level in Statistics 2 (WST02) Paper 01

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January 2016
Publications Code IA043349

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 IAL 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
   - ⌐ 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.

Special notes for marking Statistics exams

- If a candidate is "hedging their bets" e.g. give Attempt 1…Attempt 2…etc then please send to review.
- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct please send to review.

Question Number	Scheme	Marks
1 (a)	Any suitable problem with using the database as a sampling frame: E.g. Might not be up to date Might not contain all customers (incomplete) Might be biased	B1 (1)
(b)	B(20, 0.35)	B1 dB1 (2)
(c)	$P(X > 10) = 1 - P(X \leq 10) = 1 - 0.9468 = 0.0532$ awrt **<u>0.0532</u>**	M1 A1 (2) Total (5)
	Notes	
(a)	B1 Ignore extraneous non-contradictory comments 'Not accurate' without context is not sufficient	
(b)	1st B1 for B or binomial which must be seen in part (b) 2nd B1 dependent on 1st B1 for ([n =]20, [p =]0.35oe) which must be seen in part (b)	
(c)	M1 for writing or using $1 - P(X \leq 10)$	

Question Number	Scheme	Marks
2 (a)	$\frac{5-3}{b-a}=\frac{1}{8}\Rightarrow b-a=16$ $\quad\quad$ $\frac{a+b}{2}=4\Rightarrow a+b=8$	M1 M1
	$a=-4$ and $b=12$	A1 (3)
(b)	$[cE(X)-2=]\ 4c-2=0$ $\quad$ or $\quad$ $\int_{'-4'}^{'12'}\frac{1}{'16'}(cx-2)\ dx=0$	M1
	$c=\frac{1}{2}$	A1 (2)
(c)	$\text{Var}(X)=\frac{('12'-('-4'))^2}{12}\left(=\frac{64}{3}\right)$ $\quad$ or $\quad$ $\int_{'-4'}^{'12'}\frac{1}{'16'}x^2dx$	B1ft
	$E(X^2)=\left(\frac{64}{3}\right)'+4^2=\frac{112}{3}$ $\quad$ or $\quad$ $\left[\frac{'12'^3}{48}-\frac{'-4'^3}{48}\right]=\frac{112}{3}$	M1 A1 (3)
(d)	$P(2X>a+b)=P(X>4)=0.5$	M1 A1 (2)
		Total (10)

Notes

(a)
1st M1 for $\frac{5-3}{b-a}=\frac{1}{8}$ oe **or** a sketch of a uniform distribution with a range of 16
2nd M1 $\frac{a+b}{2}=4$ oe **or** a ske tch of a uniform distribution centred on 4
A1 both $a=-4$ **and** $b=12$

(b)
M1 for $4c-2=0$ <u>or</u> attempt correct equation for $E(cX-2)=0$ using integration

(c)
B1ft for substituting their a and b into a correct expression for $\text{Var}(X)$
or correct integral with limits (ft their a and b) for $E(X^2)$
M1 for substituting $E(X)=4$ and their $\text{Var}(X)$ into a correct expression for $E(X^2)$
or correct integration with correct use of limits (ft their a and b)
A1 for $\frac{112}{3}$ or exact equivalent

(d)
M1 for correct rearrangement up to $P(X>k)$ where $k=\frac{a+b}{2}$ (may be implied by a correct ft answer)

Question Number	Scheme	Marks
3 (a)(i)	B(60, 0.1)	B1
	$[P(Y=0)+P(Y=1)=](0.9)^{60}+60(0.1)^{1}(0.9)^{59}$	M1
(ii)	0.013777…. awrt **0.0138**	A1 (3)
(b)	Po(6)	B1
	$P(Y\leq 1)=0.01735....$ or 0.0174 from tables awrt **0.0174**	B1 (2)
(c)	N(6, 5.4)	B1
	$P(Y\leq 1)\approx P\left(Z<\frac{1.5-6}{\sqrt{5.4}}\right)$	M1 dM1
	$=P(Z<-1.936...)$	A1
	$=1-0.9738=0.0262$ (or from calc 0.02640...)	A1 (5)
(d)	(Poisson approximation is more suitable since…) E.g. *n* is large and *p* is small *p* is not close to 0.5 (b) is closer to the true value	B1 (1)
		Total (11)

Notes

(a) Mark (i) and (ii) together
B1 for writing or using B(60, 0.1)
M1 for correct expression (allow use of 60C0 and 60C1)
(Special Case: if no expression given, then answer only scores B1 M0 A0)

(b) 1st B1 for writing or using Po(6) (may be implied by a correct answer)
2nd B1 awrt 0.0174

(c) B1 mean = 6 and variance = 5.4 (may be seen in standardisation)
1st M1 $\pm\left(\frac{1.5 \text{ or } 1 \text{ or } 0.5-\textit{their mean}}{\textit{their sd}}\right)$
2nd M1 dependent on 1st M1 for using a continuity correction 1 ± 0.5

1st A1 $\frac{1.5-6}{\sqrt{5.4}}$ or awrt –1.94
2nd A1 awrt 0.026

(d) B1 for a correct supporting reason
(Condone *n* is large together with $np < 10$)
(Condone mean (6) ≈ variance (5.4))

Question Number	Scheme	Marks
4 (a)	F(2) = 1 **or** verify	
	$\frac{1}{20}(d^4)+\frac{1}{5}=1$ $\quad$ $\frac{1}{20}(2^4)+\frac{1}{5}=1$	M1
	$d=2$ $\quad$ $\therefore d=2$	A1 cso (2)
(b)	$F(1.5)=\frac{1}{20}(1.5)^4+\frac{1}{5}=\frac{29}{64}$ awrt **0.453**	M1 A1 (2)
(c)	1	B1 (1)
(d)	$\frac{1}{20}x^4+\frac{1}{5}=0.5$	M1
	$x^4=6\Rightarrow x=1.56508..$ awrt **1.57**	M1A1 (3)
(e)	$P(X>1.9)=1-F(1.9)=1-0.851605=0.148395$ $P(X<k)=0.148395$	M1 A1
	$\frac{1}{4}k=0.148395$	M1
	$k=0.59358$ awrt **0.594**	A1 (4)
		Total (12)

Notes

(a) M1 equating F(d) = 1 **or** substituting $d=2$ and verifying
A1cso for correct conclusion with no incorrect working seen (must reject $d = -2$ if given)

(b) M1 for substituting 1.5 into third line of F(x) on its own

(d) 1st M1 setting third line of F(x) = 0.5
2nd M1 solving equation as far as $x^4 = k$

(e) 1st M1 for writing or using $1-F(1.9)$
1st A1 awrt 0.148 (may be implied by k = awrt 0.59)
2nd M1 for writing or using $\frac{1}{4}k=1-F(1.9)$
2nd A1 awrt 0.594

Question Number	Scheme	Marks
5 (a)	[Po(1)] $(\mathrm{P}(X \geq 1))^2 = (1-0.3679)^2 = 0.39955041..$ awrt **0.400**	M1A1 (2)
(b)	Po(2) $\mathrm{P}(X=0) = 0.1353$ awrt **0.135**	B1 B1 (2)
(c)	$\mathrm{P}(X=4) = \mathrm{P}(X \leq 4) - \mathrm{P}(X \leq 3)[= 0.0443]$ Using tables If $\frac{w}{10} = 8$, $\mathrm{P}(X \leq 4) - \mathrm{P}(X \leq 3) = 0.0996 - 0.0424 = 0.0572$ If $\frac{w}{10} = 8.5$, $\mathrm{P}(X \leq 4) - \mathrm{P}(X \leq 3) = 0.0744 - 0.0301 = 0.0443$ $\frac{w}{10} = 8.5$, so $w = 85$.	M1 A1 A1 (3)
(d)	[H_0:] $\mu = 10$ $(\lambda = 1)$	B1 (1)
(e)	$\mathrm{P}(X \leq 14 \mid \mu = 10) = 0.9165$ $\mathrm{P}(X \leq 15 \mid \mu = 10) = 0.9513$ So critical region is $X \geq 16$	M1 A1 (2) Total (10)

Notes

(a) M1 using $(1 - \mathrm{P}(X=0))^2$

(b) 1st B1 writing or using Po(2) (may be implied by sight of e^{-2})

(c) M1 writing or using of $\mathrm{P}(X=4) = \mathrm{P}(X \leq 4) - \mathrm{P}(X \leq 3)$
1st A1 for 8.5
2nd A1 for 85

(d) Must use λ or μ with either = 10 or = 1
(Ignore H_1 if given)

(e) M1 for using Po(10)
(may be implied by e.g. $\mathrm{P}(X \geq 15) = 0.0835$ or $\mathrm{P}(X \geq 16) = 0.0487$)
A1 for $X \geq 16$ or $X > 15$ (allow any letter for X)

$\mathrm{P}(X \geq 16)$ is A0
A two-tailed critical region is A0

Question Number	Scheme	Marks
6 (a)	$\int_1^7 (ax^2+bx)\mathrm{d}x[=1]$	M1
	$\left[\frac{ax^3}{3}+\frac{bx^2}{2}\right]_1^7[=1]$	A1
	$\left(\frac{a(7^3)}{3}+\frac{b(7^2)}{2}\right)-\left(\frac{a}{3}+\frac{b}{2}\right)=1$	dM1
	$114a+24b=1$ *	A1cso
		(4)
(b)	$114(\frac{1}{90})+24b=1\Rightarrow b=-\frac{1}{90}$	B1
	$[\mathrm{E}(X)=]\int_1^7 (\frac{1}{90}x^3+'b'x^2)\mathrm{d}x$	M1
	$\left[\frac{x^4}{360}-\frac{x^3}{270}\right]_1^7,=\left(\frac{7^4}{360}-\frac{7^3}{270}\right)-\left(\frac{1}{360}-\frac{1}{270}\right)=5.4$	A1ft, A1oe
		(4)
(c)	$\int_1^x (\frac{1}{90}t^2-\frac{1}{90}t)\mathrm{d}t=\left[\frac{t^3}{270}-\frac{t^2}{180}\right]_1^x$ **or** $\int(\frac{1}{90}x^2-\frac{1}{90}x)\mathrm{d}x=\frac{x^3}{270}-\frac{x^2}{180}+c$ with $\mathrm{F}(1)=0$ or $\mathrm{F}(7)=1$	M1
	$\mathrm{F}(x)=\begin{cases}0 & x<1\\ \frac{x^3}{270}-\frac{x^2}{180}+\frac{1}{540} & 1\le x\le 7\\ 1 & x>7\end{cases}$	A1 B1
		(3)
(d)	$\mathrm{P}(X>'5.4')=1-\mathrm{F}('5.4')=1-0.42305...=0.5769....$ awrt **0.577**	M1 A1
		(2)
(e)	Since (d)>0.5, [the mean is less than the median] therefore negative (skew).	M1, A1
		(2)
		Total (15)

Notes

(a)
1st M1 attempting to integrate f(x), (at least one term $x^n \to x^{n+1}$). Ignore limits.
1st A1 fully correct integration. Ignore limits and accept any letters.
2nd dM1 dep on 1st M1. Subst in correct limits and equate to 1
2nd A1 correct solution only (answer given)

(b)
B1 for $b=-\frac{1}{90}$

1st M1 attempting to integrate xf(x), (at least one term $x^n \to x^{n+1}$). Ignore limits.
1st A1ft fully correct integration ft their value of b. (Allow if given in terms of a and b)
2nd A1 5.4 oe

(c)
M1 attempt to integrate f(x) with correct limits or with + C **and** attempt at $\mathrm{F}(1)=0$ or $\mathrm{F}(7)=1$
A1 $\frac{x^3}{270}-\frac{x^2}{180}+\frac{1}{540}$ with correct limits (allow < or ≤)
B1 for top and bottom lines with correct limits

(d)
M1 1 – F('5.4') or F(7) – F('5.4') or $\int_{'5.4'}^{7}(\frac{1}{90}x^2+'(-\frac{1}{90})'x)\,\mathrm{d}x$

(e)
M1 for correctly comparing 'their (d)' with 0.5 (may be implied by a correct comparison of mean and median ft their (d)) If no answer given in (d), then M0.
A1 for negative skew which must follow from 'their (d)' > 0.5

Question Number		Scheme	Marks
7	**(a)**	$F \sim \text{Po}(4)$	B1
		$\text{P}(F \geq 6) = 1 - 0.7851 = 0.2149$	M1 A1
		Let Y = the number of fishing trips where at least 6 fish are caught	
		$Y \sim \text{B}(5, 0.2149)$	B1
		$\text{P}(Y = 3) = 10(0.2149)^3(0.7851)^2 = 0.06117291856$ awrt **0.0612**	dM1 A1
			(6)
	(b)	H_0: $\lambda = 4$ $(\mu = 8)$ H_1: $\lambda \neq 4$ $(\mu \neq 8)$	B1
		$X \sim \text{Po}(8)$	B1
		$\text{P}(X \geq 14)$ or CR	M1
		$= 1 - \text{P}(X \leq 13) = 1 - 0.9658$ $\text{P}(X \leq 13) = 0.9658$ $\text{P}(X \leq 14) = 0.9827$	
		$= 0.0342$ CR $[(X \leq 2) \cup](X \geq 15)$	A1
		[0.0342>0.025] so do not reject H_0 or 14 is not in the critical region or Not significant	dM1
		There is not enough evidence of a change in the mean number of fish caught or number of fish caught per hour or rate of fish caught.	A1cso
			(6)
			Total (12)

Notes

(a)

1st B1 writing or using Po(4)
1st M1 writing or using $1 - \text{P}(F \leq 5)$
1st A1 for awrt 0.215
2nd B1 writing or using binomial (5, p)
2nd M1 dependent on 2nd B1 correct expression for $\text{P}(Y = 3)$ using their value of p
2nd A1 awrt 0.0612

(b)

1st B1 both hypotheses correct. Must use λ or μ
2nd B1 writing or using Po(8)
1st M1 writing $1 - \text{P}(X \leq 13)$ (may be implied by sight of 1 – 0.9658)
or for CR method: $\text{P}(X \leq 13) = 0.9658$ $\text{P}(X \leq 14) = 0.9827$
1st A1 for probability awrt 0.0342 or CR $X > 14$ or $X \geq 15$
2nd dM1 Dep. on 1st B1. Non-contradictory statement which follows from their probability/CR.
2nd A1cso correct contextual statement and fully correct solution with all other marks scored.

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