GradeMax



Mark Scheme (Results)

October 2021

Pearson Edexcel International A Level In Statistics S2 (WST02) Paper 01

GradeMax

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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.
- 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.

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 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.

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. Ignore wrong working or incorrect statements following a correct answer.

Special notes for marking Statistics exams (for AAs only)

- If a method leads to “probabilities” which are greater than 1 or less than 0 then M0 should be awarded unless the mark scheme specifies otherwise.
- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct then please send to review.
- For method marks, we generally allow or condone a slip or transcription error if these are seen in an expression. We do not, however, condone or allow these errors in accuracy marks.
- If a candidate is “hedging their bets” e.g. give Attempt 1…Attempt 2…etc then please send to review.

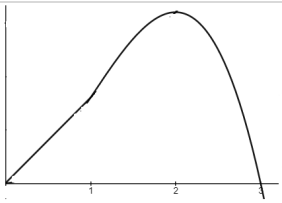
Question Number	Scheme		Marks
Throughout the paper the candidates may use different letters to the ones given in the mark scheme.			
1(a)	$P(F \leqslant 12) = 1 - P(F, 11)$		M1
	= 0.34517…	awrt 0.345	A1
			(2)
(b)	$P(8, F < 15) = P(F, 14) - P(F, 7)$		M1
	=0.81104…	awrt 0.811	A1
			(2)
(c)	$3(30 - F) + F < 70$ or $F > 10$	$3(R) + 30 - R < 70$ or $R < 20$	M1
	$P(F > 10) = 1 - P(F, 10)$	$P(R < 20) = P(R, 19)$	M1
	= 0.4922…	awrt 0.492	A1
			(3)
(d)	H_0: $p = 0.35$ H_1: $p > 0.35$		B1
	Let Y be the number of customers who do **not** buy free range eggs. $Y \sim N(70, 45.5)$		M1
	$P(Y \geqslant 86) \approx P\left(Z > \frac{85.5 - 70}{\sqrt{45.5}}\right)$ or $\pm\frac{x - 0.5 - 70}{\sqrt{45.5}} = 1.6449$		M1 M1
	$\approx 0.01078...$ or 81.595…		A1
	There is evidence to reject H_0. In the critical region		dM1
	There is evidence to support the **manager's** belief /There is evidence to support the proportion of customers who do **not** buy free range eggs is more than 35% (o.e)		A1
			(7)
			Total 14

(a)	**M1**	Writing or using $1 - P(F, 11)$
	A1	awrt 0.345
(b)	**M1**	$P(F, 14) - P(F, 7)$
	A1	awrt 0.811
(c)	**M1**	Allow equation instead of inequality (may be implied by 2nd M1)
	M1	Writing or using $1 - P(F, 10)$ ft their 10 but must be finding the correct tail.
	A1	awrt 0.492
(d)	**B1**	Both hypotheses in terms of p or π
	M1	Writing or using a normal distribution with a mean of 70
	M1	Standardising using 85.5/86/86.5, their mean and their sd
	M1	Using a continuity correction 86 ± 0.5
	A1	Correct probability awrt 0.0108 or awrt 0.0107 or x value of awrt 82 or allow awrt 2.29… and 1.6449 seen **NB** exact Binomial 0.01156 Po approx. awrt 0.0352
	dM1	(dep on 1st M1) A correct statement based on comparing 86 with their CR or their prob with 0.05 [condone 0.989 > 0.95]– contradicting non-contextual comments M0
	A1	A correct statement in context. **NB** award M1A1 for a correct contextual statement on its own.

Question Number	Scheme	Marks
2(i)(a)	$\mathrm{P}(X>14)=\frac{2}{5}$ oe	B1
		(1)
(b)	$a=8-2(14-8)[=-4]$	M1
	$b=14+2(14-8)[=26]$	M1
	$\mathrm{P}(6X>a+b)=\left(\frac{26-\frac{26-4}{6}}{26+4}\right)$ oe	M1
	$=\frac{67}{90}$ oe awrt 0.744	A1
		(4)
(ii)(a)	$S \sim \mathrm{U}[0,22.5]$ or $\mathrm{f}(s)=\begin{cases}\frac{2}{45} & 0 \leqslant s \leqslant 22.5\\ 0 & \text{otherwise}\end{cases}$	B1
		(1)
(b)	$\mathrm{P}(S<12)=\frac{12}{"22.5"}$	M1
	$=\frac{8}{15}$ awrt 0.533	A1
		(2)
(c)	$\mathrm{P}(T=6)={}^{20}\mathrm{C}_6\left("\frac{8}{15}"\right)^6\left(1-"\frac{8}{15}"\right)^{14}$	M1M1
	= 0.02072… awrt 0.0207	A1
		(3)
		Total 11

Notes

(i)(a)	**B1**	Allow 0.4
(b)	**M1**	A correct method to find the value of a or $\frac{a+b}{2}=11$ May be awarded in part(a)
	M1	A correct method to find the value of b or a second correct equation ft their (a) eg $\frac{b-14}{b-a}=\frac{2}{5}$ May be awarded in part(a)
	M1	A correct probability expression using their value for a and their value for b
	A1	Correct answer
(ii)(a)	**B1**	Correct distribution stated allow in words. Condone <
(b)	**M1**	Correct method ft their value of $(b - a)$ if positive. Condone 45 in the denominator for this mark
	A1	Awrt 0.533
(c)	**M1**	For $\left("\frac{8}{15}"\right)^6\left("1-\frac{8}{15}"\right)^{14}$
	M1	Fully correct probability ft their 8/15
	A1	awrt 0.0207

Question Number	Scheme	Marks
3(a)	$4a = a(b) \Rightarrow b = 4$ *	B1*cso
		(1)
(b)	$a(27b - 81 + 1) = 1$	M1
	$a = \frac{1}{28}$	A1
		(2)
(c)	$P(X > 2.25) = 1 - F(2.25)$	M1
	$= 0.25237\ldots$ awrt 0.252	A1
		(2)
(d)(i)	$f(x) = \frac{3}{7}x^2 - \frac{1}{7}x^3$ or $\frac{2}{7}x$	M1
	 Sketch	B1
(ii)	$f'(x) = \frac{6}{7}x - \frac{3}{7}x^2$	dM1
	$\frac{6}{7}x - \frac{3}{7}x^2 = 0$	dM1
	Mode = 2	A1
		(5)
		Total 10

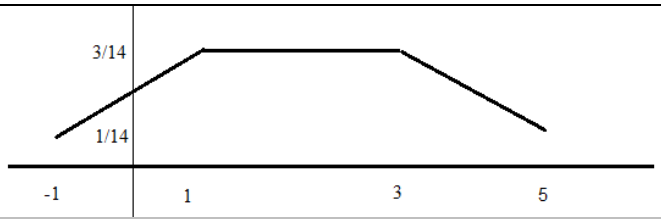
		Notes
In this question award mark all parts together		
(a)	**B1***	Answer given so need to see $4a = a(b)$ allow $4a(1) = a(b(1) - 1 + 1)$ followed by $b = 4$
(b)	**M1**	For a correct equation
	A1	1/28 o.e.
(c)	**M1**	For 1 – F(2.25) or F(3) – F(2.25) Implied by a correct answer
	A1	awrt 0.252
(d)(i)	**M1**	Differentiating to find f(x), one term correct or correct follow through. Condone missing a Differentiation may be seen anywhere in the question. $f(x) = a\left(12x^2 - 4x^3\right)$ or $8ax$
	B1	Sketch of pdf. Straight line followed by smooth curve with mode near the middle of the curve. Must be connected (no gap). Values not required, but must begin and end on horizontal axis.
(ii)	**dM1**	Dep on 1st M being awarded. Differentiating their f(x) (for $1 < x \leq 3$) to find $f'(x)$ $x^n \rightarrow x^{n-1}$ Condone missing a $f'(x) = a\left(24x - 12x^2\right)$
	dM1	Dep on previous M being awarded. Putting their $f'(x) = 0$
	A1	All but the B1 mark must be awarded

Question Number	Scheme		Marks
4(a)	$P(X = 8) = \frac{e^{-6}6^8}{8!}$ or 0.8472 – 0.7440		M1
	= 0.10325…	awrt 0.103	A1
			(2)
(b)	[X~Po(6) …] $P(X \ldots n) < 0.05$ or $P(X \ldots n-1) > 0.95$		M1
	$n = 11$		A1cao
			(2)
(c)	K~Po(0.6m) **and** $P(K = 0) < 0.05$ / $e^{-0.6m} < 0.05$ / $-0.6m < \ln 0.05$ oe	or $\lambda = 3$	M1
	$m = 5$		A1cao
			(2)
(d)	Y~Po(3)		B1
	$P(Y \ldots 1) = 1 - P(Y = 0)$		M1
	= 0.9502		A1
			(3)
(e)	[$W \sim$ Po(18)] $P(W = 15) = \frac{e^{-18}18^{15}}{15!}$ [= 0.078575…]	$Y \sim B(15, \frac{5}{30})$	M1
	$\frac{P(Y = 1[\lvert Y \sim Po(3)]) \times P(T = 14[\lvert T \sim Po(15)])}{"0.078575..."}$	P(Y = 1)	dM1
	$= \frac{(e^{-3} \times 3)[= 0.149...] \times \left(\frac{e^{-15}15^{14}}{14!}\right)[= 0.102...]}{"0.078575..."}$	$=15(\frac{1}{6})(\frac{5}{6})^{14}$	dM1
	= 0.1947…	awrt 0.195	A1
			(4)
(f)	J~Po(9)		M1
	$P(J \le 13) = 0.9261$ $P(J \le 14) = 0.9585$		
	So critical region is $J \ge 15$		A1
			(2)
			Total 15

		Notes
(a)	**M1**	Correct formula or correct use of tables
	A1	awrt 0.103
(b)	**M1**	A correct probability statement. Implied by correct answer
	A1	cao
(c)	**M1**	Forming an equation or inequality or identifying $\lambda = 3$
	A1	cao
(d)	**B1**	Writing Po(3) [implied by 0.0498… or correct answer]
	M1	Writing or using $1 - P(Y = 0)$
	A1	Allow 0.95 or better
(e)	**M1**	Using Po(18) to find P(W =15)
	dM1	(dep on 1st M1) Attempt at conditional probability with P(Y =1)×P(T = 14) (any value of λ) on num. and their P(W =15) on denom. (may be implied)
	dM1	(dep on 2nd M1) Correct ratio of probabilities
	A1	awrt 0.195
ALT:		Use of Binomial: 1st M1 correct distribution, 2nd dM1 P(Y = 1), 3rd dM1 correct expression
(f)	**M1**	Writing or using Po(9) Implied by correct CR
	A1	Cao . Allow J >14. Do not allow as part of a probability statement.

uestion Number	Scheme	Marks
5(a)	P(score 8) = $0.25 \times 0.35 = 0.0875$	B1
		(1)
(b)	<table><tr><th>sample</th><th>Score (y)</th><th>calculation</th><th>P($Y = y$)</th></tr><tr><td>(1,3)</td><td>–2</td><td>0.4×0.25</td><td>0.1</td></tr><tr><td>(1,2)</td><td>0</td><td>0.4×0.35</td><td>0.14</td></tr><tr><td>(1,1) (2,3)</td><td>2</td><td>$0.4^2 + 0.35 \times 0.25$</td><td>0.2475</td></tr><tr><td>(2,2)</td><td>4</td><td>0.35^2</td><td>0.1225</td></tr><tr><td>(2,1) (3,3)</td><td>6</td><td>$0.35 \times 0.4 + 0.25^2$</td><td>0.2025</td></tr><tr><td>(3,1)</td><td>10</td><td>0.25×0.4</td><td>0.1</td></tr></table>	B1 M1 M1 M1
	<table><tr><td>Y</td><td>–2</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td></tr><tr><td>P($Y = y$)</td><td>0.1 $\left[\frac{1}{10}\right]$</td><td>0.14 $\left[\frac{7}{50}\right]$</td><td>0.2475 $\left[\frac{99}{400}\right]$</td><td>0.1225 $\left[\frac{49}{400}\right]$</td><td>0.2025 $\left[\frac{81}{400}\right]$</td><td>0.0875 $\left[\frac{7}{80}\right]$</td><td>0.1 $\left[\frac{1}{10}\right]$</td></tr></table>	A1
		(5)
(c)	$E(Y) = -2 \times "0.1" + [0 \times "0.14"] + 2 \times "0.2475" + 4 \times "0.1225" + 6 \times "0.2025" + 8 \times 0.0875 + 10 \times "0.1"$	M1
	= 3.7	A1
		(2)
		Total 8

		Notes
(a)	**B1**	A correct calculation shown followed by 0.0875
(b)	**B1**	For identifying the correct set of y values. Any extras must have a probability of 0 May be split eg 2 may appear twice
	M1	For at least two correct calculations **or** probs from P($Y = -2$), P($Y = 0$) , P($Y = 4$) or P($Y = 10$)
	M1	For at least one correct calculation **or** prob for P($Y = 2$) or P($Y = 6$)
	M1	For at least four correct calculations **or** probs attached to the correct value of y or sample
	A1	A fully correct answer
(c)	**M1**	Correct expression ft their table
	A1	3.7 or exact equivalent
		Alternative for (c) M1 $E(X) = 0.4 + 2 \times 0.35 + 3 \times 0.25 \ [= 1.85]$ and $E(Y) = 4 \times "1.85" - 2 \times "1.85"$

Qu'n Number	Scheme	Marks
6(a)		B1 B1
		(2)
(b)	$\mathrm{E}(Y)=2$	B1
	$\mathrm{Var}(2Y-3)=4\mathrm{Var}(Y)$	M1
	$\mathrm{Var}(Y)=\left(\frac{131}{21}-2^2\right)$	M1
	$\mathrm{Var}(2Y-3)=\frac{188}{21}$ awrt 8.95	A1
		(4)
(c)	$\int_{-1}^{t}\frac{1}{14}(y+2)\mathrm{d}y=\frac{1}{14}\left[\frac{y^2}{2}+2y\right]_{-1}^{t}$ **or** $\int\frac{1}{14}(y+2)\mathrm{d}y=\frac{1}{14}\left[\frac{y^2}{2}+2y\right]+C$ **or** $\int\frac{1}{14}(y+2)\mathrm{d}y=\frac{1}{28}(y+2)^2+C$	M1
	$\frac{1}{14}\left[\left(\frac{t^2}{2}+2t\right)-\left(\frac{1}{2}-2\right)\right]$ **or** $\frac{1}{14}\left[\frac{(-1)^2}{2}-2\right]+C=0$ & $C=\frac{3}{28}$ **or** $\frac{1}{28}(-1+2)^2+C=0$ & $C=-\frac{1}{28}$ leading to $\frac{1}{14}\left(\frac{y^2}{2}+2y+\frac{3}{2}\right)$*	A1*cso
		(2)
(d)	$\int_1^t\frac{3}{14}\mathrm{d}y+\mathrm{F}(1)=\left[\frac{3}{14}y\right]_1^t+\mathrm{F}(1)=\left[\left(\frac{3t}{14}\right)-\left(\frac{3}{14}\right)\right]+\mathrm{F}(1)$ or $\int\frac{3}{14}\mathrm{d}y=\left[\frac{3}{14}y\right]+C$ and use of F(1) = "their F(1)" or F(3) = " their F(3)"	M1
	$\int_3^t\frac{1}{14}(6-y)\mathrm{d}y+\mathrm{F}(3)=\frac{1}{14}\left[6y-\frac{y^2}{2}\right]_3^t+\mathrm{F}(3)=\frac{1}{14}\left[\left(6t-\frac{t^2}{2}\right)-\left(18-\frac{9}{2}\right)\right]+\mathrm{F}(3)$ or $\int\frac{1}{14}(6-y)\mathrm{d}x=\frac{1}{14}\left[6y-\frac{y^2}{2}\right]+C$ or $C-\frac{(6-y)^2}{28}$ and use F(5) =1	M1
	$\mathrm{F}(y)=\begin{cases}0 & y\leq -1\\ \frac{1}{14}\left(\frac{y^2}{2}+2y+\frac{3}{2}\right) & -1<y\leq 1\\ \frac{3}{14}y+\frac{1}{14} & 1<y\leq 3\\ \frac{3}{7}y-\frac{1}{28}y^2-\frac{1}{4} & 3<y\leq 5\\ 1 & y>5\end{cases}$	A1 A1 B1
		(5)

(e)	$"\frac{3}{14}m+\frac{1}{14}"=0.3$	M1
	$m=\frac{16}{15}$	A1
		(2)
(f)	$\mathrm{P}\left(4Y\le 5 \mid Y\le 3\right)=\frac{\left(\frac{3}{14}\times\frac{5}{4}+\frac{1}{14}\right)}{\left(\frac{3}{14}\times 3+\frac{1}{14}\right)}\left[=\frac{19/56}{5/7}\right]$	M1
	$=\frac{19}{40}$ or 0.475	A1
		(2)
		Total 17

		Notes
(a)	**B1**	Shape correct – must not touch/cross the *x*-axis
	B1	Fully correct including labels (all *x*-axis and at least one vertical axis label which may be 2/14)
(b)	**B1**	Correct value for E(*Y*)
	M1	Writing or using 4 Var (*Y*) on its own
	M1	Correct formula for Var (*Y*) allow use of their E(*Y*) if clearly stated
	A1	awrt 8.95
(c)	**M1**	For a correct method for $-1 < y \leqslant 1$ Allow finding the area: attempt at trapezium $\times(y+1)$ $\frac{1}{2}\left(\frac{1}{14}+\frac{1}{14}(y+2)\right)(y+1)$
	A1*cso	A fully correct solution with substitution seen or *C* found leading to $\frac{1}{14}\left(\frac{y^2}{2}+2y+\frac{3}{2}\right)$ Allow any letter
(d)	**M1**	For a correct method for $1 < y \leqslant 3$ Allow finding the area $\left(\frac{1}{14}+\frac{3}{14}\right)+\frac{3}{14}(y-1)$ or $\mathrm{F}(1)+\frac{3}{14}(y-1)$
	M1	For a correct method for $3 < y \leqslant 5$ Allow finding the area $\left(\frac{1}{14}+\frac{3}{14}\right)+\frac{6}{14}+\frac{1}{2}\left(\frac{3}{14}+\frac{1}{14}(6-y)\right)(y-3)$ or $\mathrm{F}(3)+\frac{1}{2}\left(\frac{3}{14}+\frac{1}{14}(6-y)\right)(y-3)$
	A1	For a correct expression attached to $1 < y \leqslant 3$
	A1	For a correct expression attached to $3 < y \leqslant 5$ Allow $\frac{29-(6-y)^2}{28}$ oe
	B1	Top, 2nd and bottom line correct plus all in terms of the same letter. Allow < for ≤ and vice versa
(e)	**M1**	Setting their equation for $1 < y \leqslant 3$ equal to 0.3
	A1	cao
(f)	**M1**	For writing or using $\frac{\mathrm{F}(\frac{5}{4})}{\mathrm{F}(3)}$ Allow use of their expression for $3 < y \leqslant 5$ for the denominator
	A1	cao

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