



# Mark Scheme (Results)

October 2021

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

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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.

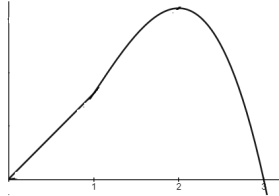
- bod – benefit of doubt
  - ft – follow through
  - the symbol  $\surd$  will be used for correct ft
  - cao – correct answer only
  - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
  - isw – ignore subsequent working
  - awrt – answers which round to
  - SC: special case
  - oe – or equivalent (and appropriate)
  - dep – dependent
  - indep – independent
  - dp decimal places
  - sf significant figures
  - \* The answer is printed on the paper
  - $\square$  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
<b>Throughout the paper the candidates may use different letters to the ones given in the mark scheme.</b>			
1(a)	$P(F \leq 12) = 1 - P(F \geq 11)$		M1
	$= 0.34517\dots$	awrt 0.345	A1
			(2)
(b)	$P(8 \leq F < 15) = P(F \leq 14) - P(F \leq 7)$		M1
	$= 0.81104\dots$	awrt 0.811	A1
			(2)
(c)	$3(30 - F) + F < 70$ or $F > 10$	$3(R) + 30 - R < 70$ or $R < 20$	M1
	$P(F > 10) = 1 - P(F \leq 10)$	$P(R < 20) = P(R \leq 19)$	M1
	$= 0.4922\dots$		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 <b>not</b> buy free range eggs. $Y \sim N(70, 45.5)$		M1
	$P(Y \leq 86) \approx P\left(Z > \frac{85.5 - 70}{\sqrt{45.5}}\right)$ or $\pm \frac{x - 0.5 - 70}{\sqrt{45.5}} = 1.6449$		M1 M1
	$\approx 0.01078\dots$ or $81.595\dots$		A1
	There is evidence to reject $H_0$ . In the critical region		dM1
	There is evidence to support the <b>manager's</b> belief / There is evidence to support the <u>proportion</u> of customers who <u>do not</u> buy free range eggs is <u>more than 35%</u> (o.e)		A1
			(7)
			Total 14
(a)	<b>M1</b> <b>A1</b>	Writing or using $1 - P(F \geq 11)$ awrt 0.345	
(b)	<b>M1</b> <b>A1</b>	$P(F \leq 14) - P(F \leq 7)$ awrt 0.811	
(c)	<b>M1</b> <b>M1</b> <b>A1</b>	Allow equation instead of inequality (may be implied by 2 <sup>nd</sup> M1) Writing or using $1 - P(F \leq 10)$ ft their 10 but must be finding the correct tail. awrt 0.492	
(d)	<b>B1</b> <b>M1</b> <b>M1</b> <b>M1</b> <b>A1</b> <b>dM1</b> <b>A1</b>	Both hypotheses in terms of $p$ or $\pi$ Writing or using a normal distribution with a mean of 70 Standardising using 85.5/86/86.5, their mean and their sd Using a continuity correction $86 \pm 0.5$ Correct probability awrt 0.0108 or awrt 0.0107 or $x$ value of awrt 82 or allow awrt 2.29... and 1.6449 seen <b>NB</b> exact Binomial 0.01156 Po approx. awrt 0.0352 (dep on 1 <sup>st</sup> 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 A correct statement in context. <b>NB</b> award M1A1 for a correct contextual statement on its own.	

Question Number	Scheme		Marks
2(i)(a)	$P(X > 14) = \frac{2}{5}$ oe		B1
			(1)
(b)	$a = 8 - 2(14 - 8) [= -4]$		M1
	$b = 14 + 2(14 - 8) [= 26]$		M1
	$P(6X > a + b) = \left( \frac{26 - \frac{26-4}{6}}{26+4} \right)$ oe		M1
	$= \frac{67}{90}$ oe		awrt 0.744 A1
			(4)
(ii)(a)	$S \square U[0, 22.5]$ or $f(s) = \begin{cases} \frac{2}{45} & 0 \leq s \leq 22.5 \\ 0 & \text{otherwise} \end{cases}$		B1
			(1)
(b)	$P(S < 12) = \frac{12}{22.5}$		M1
	$= \frac{8}{15}$		awrt 0.533 A1
			(2)
(c)	$P(T = 6) = {}^{20}C_6 \left( \frac{8}{15} \right)^6 \left( 1 - \frac{8}{15} \right)^{14}$		M1M1
	$= 0.02072\dots$		awrt 0.0207 A1
			(3)
Total 11			
<b>Notes</b>			
(i)(a)	<b>B1</b>	Allow 0.4	
(b)	<b>M1</b>	A correct method to find the value of $a$ or $\frac{a+b}{2} = 11$ May be awarded in part(a)	
	<b>M1</b>	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)	
(ii)(a)	<b>M1</b>	A correct probability expression using their value for $a$ and their value for $b$	
	<b>A1</b>	Correct answer	
(b)	<b>B1</b>	Correct distribution stated allow in words. Condone <	
(c)	<b>M1</b>	Correct method ft their value of $(b - a)$ if positive. Condone 45 in the denominator for this mark	
	<b>A1</b>	Awrt 0.533	
(c)	<b>M1</b>	For $\left( \frac{8}{15} \right)^6 \left( 1 - \frac{8}{15} \right)^{14}$	
	<b>M1</b>	Fully correct probability ft their 8/15	
	<b>A1</b>	awrt 0.0207	

Question Number	Scheme		Marks
3(a)	$4a = a(b) \Rightarrow b = 4^*$		B1*cs0 (1)
(b)	$a(27b - 81 + 1) = 1$		M1
	$a = \frac{1}{28}$		A1 (2)
(c)	$P(X > 2.25) = 1 - F(2.25)$		M1
	$= 0.25237\dots$	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
			B1
	Sketch		
(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			
<b>In this question award mark all parts together</b>			
(a)	<b>B1*</b>	Answer given so need to see $4a = a(b)$ allow $4a(1) = a(b(1) - 1 + 1)$ followed by $b = 4$	
(b)	<b>M1</b> <b>A1</b>	For a correct equation $1/28$ o.e.	
(c)	<b>M1</b> <b>A1</b>	For $1 - F(2.25)$ or $F(3) - F(2.25)$ Implied by a correct answer awrt 0.252	
(d)(i)	<b>M1</b>	Differentiating to find $f(x)$ , one term correct or correct follow through. Condone missing $a$ Differentiation may be seen anywhere in the question. $f(x) = a(12x^2 - 4x^3)$ or $8ax$	
	<b>B1</b>	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)	<b>dM1</b>	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 $a$ $f'(x) = a(24x - 12x^2)$	
	<b>dM1</b> <b>A1</b>	Dep on previous M being awarded. Putting their $f'(x) = 0$ 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
	$= 0.10325\dots$		A1
	awrt 0.103		(2)
(b)	[ $X \sim \text{Po}(6) \dots$ ] $P(X \leq n) < 0.05$ or $P(X \leq n-1) > 0.95$ r		M1
	$n = 11$		A1cao
			(2)
(c)	$K \sim \text{Po}(0.6m)$ and $P(K = 0) < 0.05$ / $e^{-0.6m} < 0.05$ / $-0.6m < \ln 0.05$ or $\lambda = 3$		M1
	$m = 5$		A1cao
			(2)
(d)	$Y \sim \text{Po}(3)$		B1
	$P(Y \leq 1) = 1 - P(Y = 0)$		M1
	$= 0.9502$		A1
			(3)
(e)	[ $W \sim \text{Po}(18)$ ] $P(W = 15) = \frac{e^{-18} 18^{15}}{15!}$ [= 0.078575... ]		$Y \sim B(15, \frac{5}{30})$ M1
	$\frac{P(Y = 1 [Y \sim \text{Po}(3)]) \times P(T = 14 [T \sim \text{Po}(15)])}{\text{"0.078575..."}}$		$P(Y = 1)$ dM1
	$(e^{-3} \times 3) [= 0.149\dots] \times \left( \frac{e^{-15} 15^{14}}{14!} \right) [= 0.102\dots]$		$= 15(\frac{1}{6})(\frac{5}{6})^{14}$ dM1
	$= \frac{\text{"0.078575..."}}{\text{"0.078575..."}}$		
	$= 0.1947\dots$		awrt 0.195 A1
			(4)
(f)	$J \sim \text{Po}(9)$		M1
	$P(J \leq 13) = 0.9261$		
	$P(J \leq 14) = 0.9585$		
	So critical region is $J \geq 15$		A1
			(2)
			Total 15
Notes			
(a)	<b>M1</b> <b>A1</b>	Correct formula or correct use of tables awrt 0.103	
(b)	<b>M1</b> <b>A1</b>	A correct probability statement. Implied by correct answer cao	
(c)	<b>M1</b> <b>A1</b>	Forming an equation or inequality or identifying $\lambda = 3$ cao	
(d)	<b>B1</b>	Writing Po(3) [implied by 0.0498... or correct answer]	
	<b>M1</b>	Writing or using $1 - P(Y = 0)$	
(e)	<b>A1</b>	Allow 0.95 or better	
	<b>M1</b>	Using Po(18) to find $P(W = 15)$	
	<b>dM1</b>	(dep on 1 <sup>st</sup> M1) Attempt at conditional probability with $P(Y = 1) \times P(T = 14)$ (any value of $\lambda$ ) on num. and their $P(W = 15)$ on denom. (may be implied)	
	<b>dM1</b>	(dep on 2 <sup>nd</sup> M1) Correct ratio of probabilities	
<b>ALT:</b>	<b>A1</b>	awrt 0.195	
(f)	<b>M1</b> <b>A1</b>	Use of Binomial: 1 <sup>st</sup> M1 correct distribution, 2 <sup>nd</sup> dM1 $P(Y = 1)$ , 3 <sup>rd</sup> dM1 correct expression Writing or using Po(9) Implied by correct CR Cao . Allow $J > 14$ . Do not allow as part of a probability statement.	

Question Number	Scheme		Marks																												
5(a)	$P(\text{score } 8) = 0.25 \times 0.35 = 0.0875$		B1																												
			(1)																												
(b)	<table border="1"> <thead> <tr> <th>sample</th> <th>Score (y)</th> <th>calculation</th> <th><math>P(Y = y)</math></th> </tr> </thead> <tbody> <tr> <td>(1,3)</td> <td>-2</td> <td><math>0.4 \times 0.25</math></td> <td>0.1</td> </tr> <tr> <td>(1,2)</td> <td>0</td> <td><math>0.4 \times 0.35</math></td> <td>0.14</td> </tr> <tr> <td>(1,1) (2,3)</td> <td>2</td> <td><math>0.4^2 + 0.35 \times 0.25</math></td> <td>0.2475</td> </tr> <tr> <td>(2,2)</td> <td>4</td> <td><math>0.35^2</math></td> <td>0.1225</td> </tr> <tr> <td>(2,1) (3,3)</td> <td>6</td> <td><math>0.35 \times 0.4 + 0.25^2</math></td> <td>0.2025</td> </tr> <tr> <td>(3,1)</td> <td>10</td> <td><math>0.25 \times 0.4</math></td> <td>0.1</td> </tr> </tbody> </table>		sample	Score (y)	calculation	$P(Y = y)$	(1,3)	-2	$0.4 \times 0.25$	0.1	(1,2)	0	$0.4 \times 0.35$	0.14	(1,1) (2,3)	2	$0.4^2 + 0.35 \times 0.25$	0.2475	(2,2)	4	$0.35^2$	0.1225	(2,1) (3,3)	6	$0.35 \times 0.4 + 0.25^2$	0.2025	(3,1)	10	$0.25 \times 0.4$	0.1	B1 M1 M1 M1
sample	Score (y)	calculation	$P(Y = y)$																												
(1,3)	-2	$0.4 \times 0.25$	0.1																												
(1,2)	0	$0.4 \times 0.35$	0.14																												
(1,1) (2,3)	2	$0.4^2 + 0.35 \times 0.25$	0.2475																												
(2,2)	4	$0.35^2$	0.1225																												
(2,1) (3,3)	6	$0.35 \times 0.4 + 0.25^2$	0.2025																												
(3,1)	10	$0.25 \times 0.4$	0.1																												
	<table border="1"> <thead> <tr> <th>Y</th> <th>-2</th> <th>0</th> <th>2</th> <th>4</th> <th>6</th> <th>8</th> <th>10</th> </tr> </thead> <tbody> <tr> <td><math>P(Y = y)</math></td> <td>0.1</td> <td>0.14</td> <td>0.2475</td> <td>0.1225</td> <td>0.2025</td> <td>0.0875</td> <td>0.1</td> </tr> <tr> <td></td> <td><math>[\frac{1}{10}]</math></td> <td><math>[\frac{7}{50}]</math></td> <td><math>[\frac{99}{400}]</math></td> <td><math>[\frac{49}{400}]</math></td> <td><math>[\frac{81}{400}]</math></td> <td><math>[\frac{7}{80}]</math></td> <td><math>[\frac{1}{10}]</math></td> </tr> </tbody> </table>		Y	-2	0	2	4	6	8	10	$P(Y = y)$	0.1	0.14	0.2475	0.1225	0.2025	0.0875	0.1		$[\frac{1}{10}]$	$[\frac{7}{50}]$	$[\frac{99}{400}]$	$[\frac{49}{400}]$	$[\frac{81}{400}]$	$[\frac{7}{80}]$	$[\frac{1}{10}]$	A1				
Y	-2	0	2	4	6	8	10																								
$P(Y = y)$	0.1	0.14	0.2475	0.1225	0.2025	0.0875	0.1																								
	$[\frac{1}{10}]$	$[\frac{7}{50}]$	$[\frac{99}{400}]$	$[\frac{49}{400}]$	$[\frac{81}{400}]$	$[\frac{7}{80}]$	$[\frac{1}{10}]$																								
			(5)																												
(c)	$E(Y) = -2 \times "0.1" + [0 \times "0.14"] + 2 \times "0.2475" + 4 \times "0.1225" + 6 \times "0.2025" + 8 \times 0.0875 + 10 \times "0.1"$ $= 3.7$		M1																												
			A1																												
			(2)																												
			Total 8																												
	Notes																														
(a)	<b>B1</b>	A correct calculation shown followed by 0.0875																													
(b)	<b>B1</b>	For identifying the correct set of y values. Any extras must have a probability of 0																													
		May be split eg 2 may appear twice																													
	<b>M1</b>	For at least two correct calculations <b>or</b> probs from $P(Y = -2)$ , $P(Y = 0)$ , $P(Y = 4)$ or $P(Y = 10)$																													
	<b>M1</b>	For at least one correct calculation <b>or</b> prob for $P(Y = 2)$ or $P(Y = 6)$																													
	<b>M1</b>	For at least four correct calculations <b>or</b> probs attached to the correct value of y or sample																													
(c)	<b>A1</b>	A fully correct answer																													
	<b>M1</b>	Correct expression fit their table																													
	<b>A1</b>	3.7 or exact equivalent																													
		<b>Alternative for (c) M1</b>																													
		$E(X) = 0.4 + 2 \times 0.35 + 3 \times 0.25 [= 1.85]$ and $E(Y) = 4 \times "1.85" - 2 \times "1.85"$																													

Qu'n Number	Scheme	Marks
6(a)		B1 B1
		(2)
(b)	$E(Y) = 2$	B1
	$\text{Var}(2Y - 3) = 4\text{Var}(Y)$	M1
	$\text{Var}(Y) = \left(\frac{131}{21} - 2^2\right)$	M1
	$\text{Var}(2Y - 3) = \frac{188}{21}$	awrt 8.95 A1
		(4)
(c)	$\int_{-1}^t \frac{1}{14}(y+2)dy = \frac{1}{14} \left[ \frac{y^2}{2} + 2y \right]_{-1}^t$ or $\int_{-1}^t \frac{1}{14}(y+2)dy = \frac{1}{14} \left[ \frac{y^2}{2} + 2y \right] + C$ or $\int \frac{1}{14}(y+2)dy = \frac{1}{28}(y+2)^2 + C$	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*cs0
		(2)
(d)	$\int_1^t \frac{3}{14}dy + F(1) = \left[ \frac{3}{14}y \right]_1^t + F(1) = \left[ \left( \frac{3t}{14} \right) - \left( \frac{3}{14} \right) \right] + F(1)$ or $\int \frac{3}{14}dy = \left[ \frac{3}{14}y \right] + C$ and use of $F(1) =$ "their $F(1)$ " or $F(3) =$ "their $F(3)$ "	M1
	$\int_3^t \frac{1}{14}(6-y)dy + F(3) = \frac{1}{14} \left[ 6y - \frac{y^2}{2} \right]_3^t + F(3) = \frac{1}{14} \left[ \left( 6t - \frac{t^2}{2} \right) - \left( 18 - \frac{9}{2} \right) \right] + F(3)$ or $\int \frac{1}{14}(6-y)dx = \frac{1}{14} \left[ 6y - \frac{y^2}{2} \right] + C$ or $C = \frac{(6-y)^2}{28}$ and use $F(5) = 1$	M1
	$F(y) = \begin{cases} 0 & y \leq -1 \\ \frac{1}{14} \left( \frac{y^2}{2} + 2y + \frac{3}{2} \right) & -1 < y \leq 1 \\ \frac{3}{14}y + \frac{1}{14} & 1 < y \leq 3 \\ \frac{3}{7}y - \frac{1}{28}y^2 - \frac{1}{4} & 3 < y \leq 5 \\ 1 & y > 5 \end{cases}$	A1 A1 B1
		(5)

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

		Notes
(a)	<b>B1</b> <b>B1</b>	Shape correct – must not touch/cross the $x$ -axis Fully correct including labels (all $x$ -axis and at least one vertical axis label which may be 2/14)
(b)	<b>B1</b> <b>M1</b> <b>M1</b> <b>A1</b>	Correct value for $E(Y)$ Writing or using 4 $\text{Var}(Y)$ on its own Correct formula for $\text{Var}(Y)$ allow use of their $E(Y)$ if clearly stated awrt 8.95
(c)	<b>M1</b>   <b>A1*cs0</b>	For a correct method for $-1 < y, 1$ Allow finding the area: attempt at trapezium $\times (y+1)$ $\frac{1}{2} \left( \frac{1}{14} + \frac{1}{14}(y+2) \right) (y+1)$ A fully correct solution with substitution seen or $C$ found leading to $\frac{1}{14} \left( \frac{y^2}{2} + 2y + \frac{3}{2} \right)$
(d)	<b>M1</b>  <b>M1</b>  <b>A1</b>  <b>A1</b>  <b>B1</b> <b>M1</b> <b>A1</b>	Allow any letter For a correct method for $1 < y, 3$ Allow finding the area $\left( \frac{1}{14} + \frac{3}{14} \right) + \frac{3}{14}(y-1)$ or $F(1) + \frac{3}{14}(y-1)$ For a correct method for $3 < y, 5$ 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 $F(3) + \frac{1}{2} \left( \frac{3}{14} + \frac{1}{14}(6-y) \right) (y-3)$ For a correct expression attached to $1 < y, 3$ For a correct expression attached to $3 < y, 5$ Allow $\frac{29 - (6-y)^2}{28}$ oe Top, 2 <sup>nd</sup> and bottom line correct plus all in terms of the same letter. Allow $<$ for $,,$ and vice versa Setting their equation for $1 < y, 3$ equal to 0.3 cao
(e)	<b>M1</b> <b>A1</b>	
(f)	<b>M1</b>  <b>A1</b>	For writing or using $\frac{F(\frac{5}{4})}{F(3)}$ Allow use of their expression for $3 < y, 5$ for the denominator cao

