



# Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Level  
In Statistics (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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

## General Instructions for Marking

The total number of marks for the paper is 75.

Edexcel Mathematics mark schemes use the following types of marks:

### 'M' marks

These are marks given for a correct method or an attempt at a correct method. In Mechanics they are usually awarded for the application of some mechanical principle to produce an equation, e.g. resolving in a particular direction; taking moments about a point; applying a suvat equation; applying the conservation of momentum principle; etc.

The following criteria are usually applied to the equation.

To earn the M mark, the equation

- (i) should have the correct number of terms
- (ii) each term needs to be dimensionally correct

For example, in a **moments equation, every term must be a 'force x distance' term or 'mass x distance', if we allow them to cancel 'g' s.**

For a resolution, all terms that need to be resolved (multiplied by sin or cos) must be resolved to earn the M mark.

**'M' marks are sometimes** dependent (DM) on previous M marks having been earned, e.g. when two simultaneous equations have been set up by, for example, resolving in two directions and there is then an M mark for solving the equations to find a particular quantity – this M mark is often dependent on the two previous M marks having been earned.

### 'A' marks

These are dependent accuracy (or sometimes answer) marks and can only be awarded if the previous M mark has been earned. e.g. M0 A1 is impossible.

### 'B' marks

These are independent accuracy marks where there is no method (e.g. often given for a comment or for a graph).

A and B marks may be f.t. – follow through – marks.

### General Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod means benefit of doubt
- ft means follow through
  - the symbol  $\surd$  will be used for correct ft
- cao means correct answer only
- cso means correct solution only, i.e. there must be no errors in this part of the question to obtain this mark
- isw means ignore subsequent working

- awrt means answers which round to
- SC means special case
- oe means or equivalent (and appropriate)
- dep means dependent
- indep means independent
- dp means decimal places
- sf means significant figures
- \* means the answer is printed on the question paper
- $\square$  means the second mark is dependent on gaining the first mark

**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.

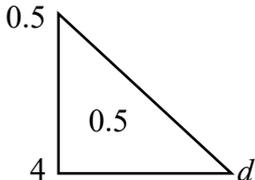
For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

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.

Ignore wrong working or incorrect statements following a correct answer.

Question Number	Scheme		Marks
1 (a) (i)	$X \sim B(14, 0.2)$		
	$[P(X = 2) = ]^{14}C_2 \times 0.2^2 \times 0.8^{12}$		M1
	$= 0.2501$	awrt 0.2501	A1
	$X \sim B(25, 0.2)$		
	$P(X > 3) = 1 - P(X \leq 3) = 1 - 0.2340$ or $1 - (0.0038 + 0.0236 + 0.0708 + 0.1358)$		M1
(ii)	$= 0.7660$		A1
			(4)
(b)(i)	$[np = 6 \Rightarrow] n = \frac{6}{0.2}$		M1
	$= 30$		A1
			(2)
(ii)	$Y \sim B(n, 0.2)$ we require $P(Y \geq 1) > 0.95$		
	$1 - P(Y = 0) > 0.95 \Rightarrow P(Y = 0) < 0.05$		M1
	$[{}^n C_0 \times 0.2^0] \times 0.8^n < 0.05$		M1
	$0.8^{14} = 0.04398... [< 0.05]$	$n > \frac{\ln 0.05}{\ln 0.8} \Rightarrow n > 13.425$	dM1
	$n = 14$		A1
		(4)	
<b>Notes</b>			<b>Total 10</b>
(a) (i)	<b>M1</b>	For writing or using ${}^{14}C_2 \times 0.2^2 \times 0.8^{12}$ (Allow 91 for ${}^{14}C_2$ )	
	<b>A1</b>	awrt 0.2501 <b>NB</b> 0.2501 with no working scores M1A1	
(ii)	<b>M1</b>	For writing or using $1 - P(X \leq 3)$	
	<b>A1</b>	awrt 0.766 <b>NB</b> awrt 0.766 with no working scores M1A1	
(b)(i)	<b>M1</b>	For use of $np = 6$ e.g. $0.2n = 6$ (Allow $\geq$ )	
	<b>A1</b>	Cao	
(ii)	<b>M1</b>	For writing or using $P(Y \geq 1) = 1 - P(Y = 0)$ (Allow $P(Y \geq 1) = 1 - P(Y \leq 0)$ )	
	<b>M1</b>	For $0.8^n < 0.05$ oe (Allow = or $\leq$ )	
	<b>dM1</b>	Dependant on previous M1 For substitution of $n$ (allow $0.8^{13} = 0.05497...$ ) or rearranging to $n > ...$ (Allow = or $\geq$ ) If using logs allow any base e.g. $n > \log_{0.8} 0.05$	
	<b>A1</b>	Cao	

Question Number	Scheme		Marks
2 (a)	[Mode =] 4		B1 (1)
(b)	$\left[ a \int_0^4 x^3 dx = \frac{1}{2} \Rightarrow \right] a \left[ \frac{x^4}{4} \right]_0^4 = \frac{1}{2}$		M1
	$64a = \frac{1}{2} \Rightarrow a = \frac{1}{128} *$		A1* (2)
(c)	 $\frac{1}{2} \times \frac{1}{2} \times (d-4) = \frac{1}{2}$ or $\frac{1}{2} \times \frac{1}{2} \times (d-4) + \int_0^4 ax^3 dx = 1$		M1
	$d = 6$		A1 (2)
(d)	$b = \frac{-\frac{1}{2}}{6-4} \left[ = -\frac{1}{4} \right]$	$4b + c = 0.5$ oe	M1
	$0 = -\frac{1}{4} \times 6 + c$ or $\frac{1}{2} = -\frac{1}{4} \times 4 + c$	$10b + 2c = 0.5$ oe or $6b + c = 0$ oe	M1
	$b = -\frac{1}{4}$ and $c = \frac{3}{2}$		A1 (3)
<b>Notes</b>			<b>Total 8</b>
(a)	<b>B1</b>	Cao	
(b)	<b>M1</b>	For integrating the 1 <sup>st</sup> line of the pdf and setting = 0.5 Ignore limits	
	<b>A1*</b>	Answer is given so a correct solution must be seen with no errors. There must be at least one line of correct working from the M mark to the final answer.	
<b>Mark parts c and d together</b>			
(c)	<b>M1</b>	For setting the area of the triangle = 0.5	
	<b>A1</b>	Cao	
(d)	<b>M1</b>	A correct method for finding $b$ ft their $d$ value or $4b + c = 0.5$ oe (this may be seen any part of this question) Allow $4b + c = 64a$	
	<b>M1</b>	A correct method for finding $c$ ft their $b$ and $d$ value or $10b + 2c = 0.5$ oe or $6b + c = 0$ oe (these may be seen any part of this question) Allow $db + c = 0$	
	<b>A1</b>	For both $b$ and $c$ correct <b>NB</b> $b = -0.25$ oe and $c = 1.5$ oe will score 3/3	

Question Number	Scheme		Marks
3 (a)(i)	$3 + [0] + 29 = 32^*$		B1*
(ii)	$3 + 15 + 29 = 47^*$		B1*
			(2)
(b)	$f(t) = \begin{cases} \frac{1}{15} & 32 \leq t \leq 47 \\ 0 & \text{otherwise} \end{cases}$		M1 A1
			(2)
(c) (i)	[E(T) =] 39.5 oe		B1
(ii)	[Var(T) =] $\frac{(47-32)^2}{12}$		M1
	$\frac{75}{4} = 18.75$		A1
			(3)
(d)	$(40-32) \times \frac{1}{15}$		M1
	$= \frac{8}{15}$		A1
			(2)
<b>Notes</b>			<b>Total 9</b>
(a)(i)	<b>B1*</b>	For $3 + [0] + 29$	
(ii)	<b>B1*</b>	For $3 + 15 + 29$ Allow $32 + 15$	
(b)	<b>M1</b>	For $f(t) = \frac{1}{15} \quad 32 \leq t \leq 47$ Allow use of $<$ instead of one/both $\leq$ signs. Allow the use of any letter for $f(t)$ and $t$ (Condone inconsistent use of letters) but we must have $f(t)$ and an inequality	
	<b>A1</b>	Fully correct pdf $f(t) = \begin{cases} \frac{1}{15} & 32 \leq t \leq 42 \\ 0 & \text{otherwise} \end{cases}$ Must be $f(t)$ and $t$ . Condone $f(T)$ and $T$ Allow use of $<$ instead of one/both $\leq$ signs Allow equivalent for the 0 otherwise.	
(c)(i)	<b>B1</b>	For 39.5 oe	
(ii)	<b>M1</b>	For use of $\text{Var}(T) = \frac{(\beta - \alpha)^2}{12}$	
	<b>A1</b>	For 18.75 oe	
(d)	<b>M1</b>	For use of $(40 - \alpha) \times \frac{1}{\beta - \alpha}$	
	<b>A1</b>	For $\frac{8}{15}$ oe Allow awrt 0.533	

Question Number	Scheme			Marks							
4 (a)	$0.2 \times \pounds 10 + 0.3 \times \pounds 12 + 0.5 \times \pounds 15$			M1							
	$= [\pounds] 13.10$			A1							
				(2)							
(b)	10 10 10	12 12 12	15 15 15	B1 B1							
	10 10 12 ( $\times 3$ )	12 12 15 ( $\times 3$ )	12 15 15 ( $\times 3$ )								
	10 10 15 ( $\times 3$ )	10 12 12 ( $\times 3$ )	10 15 15 ( $\times 3$ )								
	10 12 15 ( $\times 6$ )			(2)							
(c)	$P(10) = 0.2$	$P(12) = 0.3$	$P(15) = 0.5$	B1							
	Median can be 10, 12 or 15			B1							
	$P(M = 10) = 0.2^3 + 0.2^2 \times 0.3 \times 3 + 0.2^2 \times 0.5 \times 3$ or $1 - 0.8^3 - 3 \times 0.8^2 \times 0.2$			M1							
	$P(M = 12) = 0.3^3 + 0.3^2 \times 0.5 \times 3 + 0.3^2 \times 0.2 \times 3 + 0.2 \times 0.3 \times 0.5 \times 6$			M1							
	$P(M = 15) = 0.5^3 + 0.5^2 \times 0.3 \times 3 + 0.5^2 \times 0.2 \times 3$ or $1 - 0.5^3 - 3 \times 0.5^2 \times 0.5$			M1							
	<table border="1" style="width: 100%; text-align: center;"> <tr> <td><math>M</math></td> <td>10</td> <td>12</td> <td>15</td> </tr> <tr> <td><math>P(M = m)</math></td> <td><math>\frac{13}{125} = 0.104</math></td> <td><math>\frac{99}{250} = 0.396</math></td> <td><math>\frac{1}{2} = 0.5</math></td> </tr> </table>			$M$	10	12	15	$P(M = m)$	$\frac{13}{125} = 0.104$	$\frac{99}{250} = 0.396$	$\frac{1}{2} = 0.5$
$M$	10	12	15								
$P(M = m)$	$\frac{13}{125} = 0.104$	$\frac{99}{250} = 0.396$	$\frac{1}{2} = 0.5$								
				(6)							
<b>Notes</b>				<b>Total 10</b>							
(a)	<b>M1</b>	For $0.2 \times 10 + 0.3 \times 12 + 0.5 \times 15$ May be implied by a correct answer									
	<b>A1</b>	Cao Allow 13.1									
(b)	<b>B1</b>	B1 for at least 5 possible combinations. Ignore repeats. May be seen in part c									
	<b>B1</b>	For all 10 possible combinations. Ignore repeats. May be seen in part c									
(c)	<b>B1</b>	Correct probabilities – may be seen in an equation or implied by a correct probability									
	<b>B1</b>	All 3 medians and no extras									
	<b>M1</b>	A correct method for one of the probabilities (May be implied by a correct probability)									
	<b>M1</b>	A correct method for two of the probabilities (May be implied by 2 correct probabilities)									
	<b>M1</b>	A correct method for all three probabilities (May be implied by 3 correct probabilities) or 3 probabilities that add to 1									
	<b>A1</b>	Cao Need not be in a table but probabilities must be attached to the correct median									

Question Number	Scheme		Marks
5 (a)	<b>Complaints</b> received are independent or occurring at a constant rate or singly		B1 (1)
(b)(i)	$P(X < 3   X \sim \text{Po}(6)) = ]$ 0.0620	awrt 0.062	B1
(ii)	$P(X \geq 6) = ]1 - P(X \leq 5)$ or $1 - 0.4457 = 0.5543$	awrt 0.554	M1A1 (3)
(c)	$H_0 : \lambda = 6$ $H_1 : \lambda > 6$		B1
	$P(X \geq 12) = 1 - P(X \leq 11) = [1 - 0.9799]$ or $P(X \geq 11) = 1 - P(X \leq 10) = [1 - 0.9574]$		M1
	$= 0.0201$ or $CR \geq 11$		A1
	Reject $H_0$ /In the CR/Significant		M1
	There is sufficient evidence to suggest that the mean <b>number of complaints</b> received is <b>greater</b> than 6 per week		A1ft (5)
(d)	$H_0 : \lambda = 6$ $H_1 : \lambda < 6$		B1
	6 week period is $\text{Po}(36) \Rightarrow N(36, 36)$		B1
	$P(Y \leq 26) \approx P(Y < 26.5) = P\left(Z < \frac{26.5 - 36}{6}\right)$ or $\frac{x + 0.5 - 36}{\sqrt{36}} < -1.6449$		M1 M1
	$[P(Z < -1.583...)] = 0.0571$ (Calculator 0.05667...) or $x < 25.63...$		A1
	awrt 0.057	awrt 25.6	
	Do not reject $H_0$ /Not in the CR/Not significant		M1
	There is insufficient evidence to suggest that the mean <b>number of complaints</b> received after the changes made is <b>less</b> than 6 per week		A1ft (7)
<b>Notes</b>			<b>Total 16</b>
(a)	<b>B1</b>	A correct assumption. Must be in context so need ‘complaints’ and then independent/random or constant rate or singly	
(b)(i)	<b>B1</b>	awrt 0.062	
(ii)	<b>M1</b>	For writing or using $1 - P(X \leq 5)$ May be implied by awrt 0.554	
	<b>A1</b>	awrt 0.554	
(c)	<b>B1</b>	Both hypotheses correct. Must be attached to $H_0$ and $H_1$ in terms of $\lambda$ or $\mu$	
	<b>M1</b>	For writing or using $1 - P(X \leq 11)$ or $1 - P(X \leq 10)$	
	<b>A1</b>	For 0.0201 or $CR \geq 11$	
	<b>M1</b>	A correct statement – no context needed but do not allow contradicting non contextual comments	
	<b>A1ft</b>	Correct conclusion in context with the words highlighted in bold	
(d)	<b>B1</b>	Both hypotheses correct. Must be attached to $H_0$ and $H_1$ in terms of $\lambda$ or $\mu$ Allow use of 36 rather than 6	
	<b>B1</b>	For writing or using $N(36, 36)$	
	<b>M1</b>	For standardising using 25.5/26/26.5, their mean and their standard deviation or standardising using $x - 0.5/x/x + 0.5$ , their mean and their standard deviation and setting equal to $-1.6449$	
	<b>M1</b>	For a correct continuity correction written or used e.g. 26.5 or $x + 0.5$	
	<b>A1</b>	awrt 0.057 (NB Poisson used gives 0.0512685... and scores M0M0A0) or $CR < \text{awrt } 25.6$ (Allow $\leq$ )	
	<b>M1</b>	A correct statement – no context needed but do not allow contradicting non contextual comments	
	<b>A1ft</b>	Correct conclusion in context with the words in bold (Allow The mean <b>number of complaints</b> has <b>stayed the same/not changed</b> oe)	

Question Number	Scheme		Marks
6(a)	$\left[ P\left( Y < \frac{1}{4}k \mid Y < k \right) \right] = \frac{F\left(\frac{1}{4}k\right)}{F(k)} = \frac{\frac{1}{21}\left(\frac{k}{4}\right)^2}{\frac{1}{21}k^2} = \frac{1}{16} \text{ oe}$		M1 A1 (2)
(b)	$\frac{1}{21}k^2 = -\frac{1}{15}k^2 + \frac{4}{5}k - \frac{7}{5}$	$\frac{d}{dy}\left(\frac{1}{21}y^2\right) = \frac{2}{21}y$ or $\frac{d}{dy}\left(\frac{2}{15}\left(6y - \frac{y^2}{2}\right) - \frac{7}{5}\right) = \frac{2}{15}(6-y)$	M1
	$\Rightarrow 4k^2 - 28k + 49 = 0$ oe	$\frac{d}{dy}\left(\frac{1}{21}y^2\right) = \frac{2}{21}y$ & $\frac{d}{dy}\left(\frac{2}{15}\left(6y - \frac{y^2}{2}\right) - \frac{7}{5}\right) = \frac{2}{15}(6-y)$	A1
	$\Rightarrow (2k - 7)^2 = 0$	$\frac{2}{21}k = \frac{2}{15}(6-k)$	M1
	$k = \frac{7}{2}$ oe		A1
			(4)
(c)	$f(y) = \begin{cases} \frac{2}{21}y & 0 \leq y \leq '3.5' \\ \frac{2}{15}(6-y) & '3.5' < y \leq 6 \\ [0] & [\text{otherwise}] \end{cases}$		M1 M1
	$E(Y) = \frac{2}{21} \int_0^{3.5} y^2 dy + \frac{2}{15} \int_{3.5}^6 (6y - y^2) dy \Rightarrow \frac{2}{21} \left[ \frac{y^3}{3} \right]_0^{3.5} + \frac{2}{15} \left[ 3y^2 - \frac{y^3}{3} \right]_{3.5}^6$		M1 M1
	$\frac{2}{21} \left( \frac{343}{24} \right) + \frac{2}{15} \left( \frac{325}{24} \right) = \frac{19}{6} = 3.166\dots$		awrt 3.17 dM1 dA1
			(6)
<b>Total 12</b>			
(a)	<b>M1</b>	For a correct probability statement or a correct ratio of probabilities	
	<b>A1</b>	For $= \frac{1}{16}$ oe or 0.0625	
(b)	<b>M1</b>	For setting the two lines of the cdf = to each other or $\frac{2}{21}y$ or $\frac{2}{15}(6-y)$ (Implied by a correct 3TQ)	
	<b>A1</b>	For a correct 3TQ or $\frac{2}{21}y$ and $\frac{2}{15}(6-y)$	
	<b>M1</b>	For solving their 3TQ. If the 3TQ is not correct, then a correct method must be shown or setting their 2 lines of the pdf = to each other	
	<b>A1</b>	$k = 3.5$ oe <b>NB</b> $k = 3.5$ with no incorrect working scores 4/4	
(c)	<b>M1</b>	Attempting to differentiate 1 of the functions. May be seen in part (b) or in an attempt to find E(Y)	
	<b>M1</b>	Attempting to differentiate both with one correct. May be seen in part (b) or in an attempt to find E(Y)	
	<b>M1</b>	For writing or using $E(Y) = \int_0^{3.5} y f(y) dy + \int_{3.5}^6 y f(y) dy$ Ignore limits	
	<b>M1</b>	For attempting to integrate	
	<b>dM1</b>	Dependent on previous M1. For substitution of limits, must be 0 or 6 and fit their 3.5. May be implied by $\frac{49}{36}$ oe or $\frac{65}{36}$ oe or $\frac{19}{6}$ oe. If the integral is not correct, then we must see evidence of substitution.	
	<b>dA1</b>	Dependent on previous M1. For $\frac{19}{6}$ or awrt 3.17	

Question Number	Scheme		Marks
7(a)	$\frac{97.5 - \mu}{\sigma} = 1.25$	$\frac{85.5 - \mu}{\sigma} = -0.75$	M1 M1 M1 M1 M1
	$2\sigma = 12$		M1
	$\sigma = 6^* \quad [\mu = 90]$		dA1*
			(7)
(b)	$np = 90$ and $np(1 - p) = 36$		M1
	$1 - p = 0.4$		M1
	$p = 0.6$ and $n = 150$		A1
			(3)
<b>Notes</b>			<b>Total 10</b>
<b>NB</b> Condone use of $np$ for $\mu$ and $\sqrt{np(1 - p)}$ for $\sigma$			
(a)	<b>M1</b>	For standardising using 96.5/97/97.5 and = $z$ value, where $1 < z < 1.5$	
	<b>M1</b>	For standardising using 85.5/86/86.5 and = $z$ value, where $-1 < z < -0.5$	
	<b>M1</b>	For use of a correct continuity correction in either equation	
	<b>M1</b>	For a correct $z$ value used in either equation	
	<b>M1</b>	An attempt at both equations with one fully correct	
	<b>M1</b>	For solving simultaneously eliminating $\mu$ or $\sigma$ As this is a show that question then working must be seen.	
	<b>dA1</b>	Dependent on all previous M marks being awarded $\sigma = 6^*$	
(b)	<b>M1</b>	For $np = \mu$ and $np(1 - p) = \sigma^2$ Follow through their $\mu$ (Condone $npq = \sigma^2$ )	
	<b>M1</b>	For solving simultaneously. May be implied by a correct value for $p$ and $n$	
	<b>A1</b>	Both $p = 0.6$ and $n = 150$	

