Mark Scheme (Results)

Summer 2023

Pearson Edexcel International Advanced Level
In Statistics S1 (WST01)
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
- ⌐ 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:

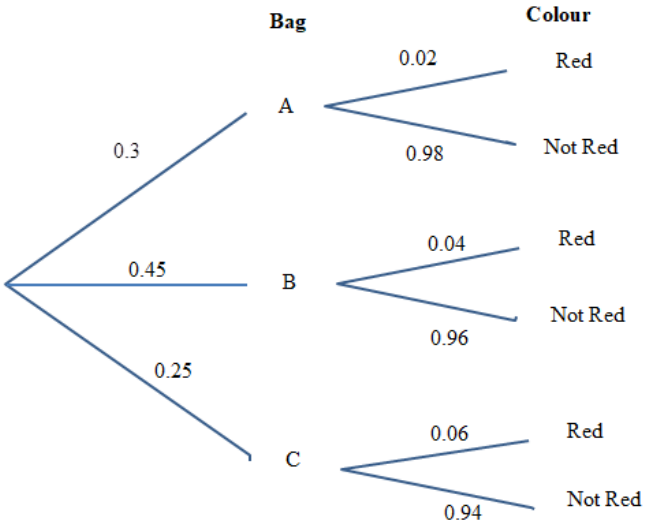
- If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
- If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

Ignore wrong working or incorrect statements following a correct answer.

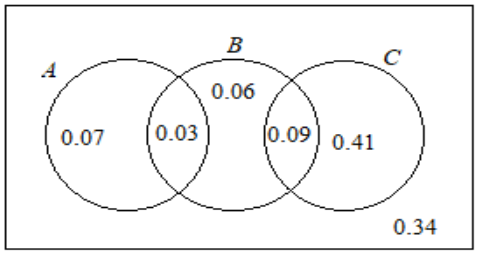
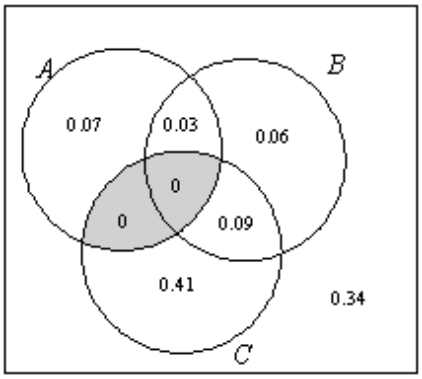
Qu	Scheme	Marks
1(a)	eg 60 people = 1.5 large squares/6 medium squares/150 small squares **or** eg 1 person = 0.025 large squares/0.6 medium squares/2.5 small squares **or** eg **[**1 small square **=]** 0.4 people/[1 medium square =] 10 people/[1 large square =] 40 people eg a correct f.d. eg 60/(20 – 10) [= 6] eg a correct frequency, 100, 70, 20, 24 associated with the appropriate bar	B1
	eg $\frac{8}{10}\times 20$ **or** $\frac{15}{30}\times 24$ **or** 8×2 **or** 0.8×15 **or** $\frac{40}{2.5}$ **or** $\frac{30}{2.5}$ **or** $8\times 5\times 0.4$ $2\times 15\times 0.4$ **or** 16 **or** 12 **or** 70×0.4	M1
	<u>28</u> people	A1
		(3)
(b)	$\text{Median} = [5]+\frac{5}{70}\times 37$ or $[10]-\frac{5}{70}\times 33$	M1
	= 7.642... **awrt 7.64**	A1
		(2)
(c)	$\sum \text{midpoint}\times\text{freq} = 2.5\times 100+7.5\times 70+15\times 60+25\times 20+45\times 24[=3255]$	M1
	$\text{Mean} = \frac{"3255"}{274}$	dM1
	= 11.879… **awrt 11.9**	A1
		(3)
	Notes	**Total 8**
(a)	B1: for finding a ratio between people and area. Allow just the numbers for 1 person or for 1 square ie 0.025, 0.6, 2.5, 0.4, 1.66 or 40 **or** calculating f.d. for any bar correctly, fd = 20, 14, 6, 2 or 0.8 Information may be seen on diagram. Must be clear it is a fd either by correct use, seen on axes associated with correct bar or stated as an fd. May be implied by M1	
	M1: for a correct method to find the number of people between 22 and 30 km **or** 30 and 45 km or between 22 and 45 km	
	A1: 28	
	NB An answer of 28 gains 3/3 unless from obvious incorrect working	
(b)	M1: Allow equivalent for $n+\frac{5}{70}\times 37$ or $\frac{Q_2-n}{5}=\frac{137-100}{170-100}$ or $n-\frac{33}{70}\times 5$ or $\frac{n-Q_2}{5}=\frac{170-137}{170-100}$ oe Allow alternative methods eg $\frac{Q_2-5}{10-Q_2}=\frac{137-170}{170-137}$ Allow 37.5 for 37, 137.5 for 137, 32.5 for 33	
	A1: awrt 7.64 or $\frac{107}{14}$ or allow **awrt 7.68** or $\frac{215}{28}$ if using n + 1 Allow awrt 7640 m or 7680 m but must have units.	
(c)	M1: Attempt at correct expression for $\sum \text{midpoint}\times\text{freq}$ - at least 3 products with correct midpoints added with at least 1 of these products fully correct . Allow for 3255	
	M1: dep on M1 being awarded for dividing “their sum” by 274	
	A1: awrt 11.9 or $\frac{3255}{274}$ Allow awrt 11900 m but must have units	

Qu	Scheme	Marks
2(a)	$S_{tw} = 2304.53 - \frac{297.8 \times 114.8}{15}$ or $S_{ww} = 6089.12 - \frac{297.8^2}{15}$	M1
	$S_{tw} = 25.367...$ **awrt 25.4**	A1
	$S_{ww} = 176.797$ **awrt 177**	A1
		(3)
(b)	$r = \frac{"25.367"}{\sqrt{5.3173 \times "176.797..."}}$	M1
	$= 0.82735....$ **awrt 0.827 or 0.828**	A1
		(2)
(c)	$b = \frac{"25.367..."}{5.3173} [= 4.77065...]$	M1
	$a = \frac{297.8}{15} - \frac{"25.367"}{5.3173} \times \frac{114.8}{15} [= -16.658....]$	M1
	b = 4.771 or better **or** a = –16.66 or better seen **and** $w = -16.7 + 4.77t$ *	A1*cso
		(3)
(d)	[On average,] for each **cm/1 cm** of tail **length/*t*** the **weight/*w* increases** by **4.77 g/grams**	B1
		(1)
(e)	$w = -16.7 + 4.77 \times 2 [= -7.16]$ or $4.77 \times 2 [= 9.54]$ or $[t =] \frac{16.7}{4.77} [= 3.5]$ or sd = awrt 0.6	M1
	$[w =] -7.16$ or 9.54 < 16.7 or 2 < 3.5 which is negative/weight cannot be negative or for sd extrapolation since a 2 cm tail is (approx 9 sd)/(more than 3 sd) from the mean	A1
		(2)
(f)	0.827	B1ft
		(1)
(g)	$2y + 10 = -16.7 + 4.77(x + 6)$ oe	B1ft
		(1)
	Notes	**Total 13**
(a)	M1 for a correct expression for S_{tw} or S_{ww}	
	A1 awrt 25.4	
	A1 awrt 177	
(b)	M1 for a valid attempt at r with their S_{tw} not equal to 2304.53 and S_{ww} not equal to 6089.12	
	A1 (M2 on epen) awrt 0.827 or awrt 0.828	
(c)	1st M1 for a correct method to find the value of b	
	2nd M1 ft their b. For a correct method to find a. Minimum shown a = awrt 19.9 – "their b" × awrt 7.65 $[= -16.658]$	
	A1* Both method marks must be awarded, equation stated (no fractions) **and** sight of (4.771 or better) **or** (−16.66 or better)	
(d)	B1 For a suitable contextual comment that implies that as length increases by 1 cm weight increases by 4.77g. Allow multiples eg each 10 cm increase in tail length weight increases by 47.7g Allow in terms of t and w	
(e)	M1 for a correct method to calculate the value of w (condone if written as a fraction) or $4.77 \times 2 [= 9.54]$ or correct method to find tail length when w = 0 or sd = awrt 0.6	
	A1 Method mark must be awarded. For –7.16 or 9.54 < 16.7 or 2 < 3.5 **with** a relevant explanation stating that weight is negative. If sd = awrt 0.6 is given allow extrapolation since a 2 cm tail is (approx 9 sd)/(more than 3 sd) from the mean.	
(f)	B1ft follow through their answer to (b)	
(g)	B1 ISW no need to be simplified. Allow equivalent eg $y = \frac{-16.7 + 4.77(x + 6)}{2} - 5$ The correct simplified equation is $y = 2.385x + 0.96$ allow awrt 2.39 and 0.96 – 0.98	

Qu	Scheme		Marks
3(a)	$\left[\bar{x} =\right]\frac{3711}{81}\left[= 45.814...\right]$	$\left[\sum l =\right]3711+81\times 600\left[= 52311\right]$	M1
	$\left[\bar{l} =\right]"45.814..."+600$	$\left[\bar{l} =\right]\frac{"52311"}{81}$	M1
	$\left[\bar{l} =\right]645.81...$ **awrt 646**		A1
			(3)
(b)	$\left[\sigma_x^{\,2} =\right]\frac{475181}{81}-\left(\frac{3711}{81}\right)^2\left[= 3767\right]$	$\left[\text{Var}(L) =\right]\frac{34088381}{81}-\left(\frac{"52311"}{81}\right)^2$	M1
	$= 3767.43... \Rightarrow \boldsymbol{\sigma_l^{\,2}} = 3767.43...$	$= 3767.43\ldots$ **awrt 3770**	A1
			(2)
(c)	40		B1cao
			(1)
(d)	IQR = 5400 – 3800 [= 1600]		M1
	$5400+1.5\times"1600"$ [= 7800] or $3800-1.5\times"1600"$ [= 1400]		M1
	7800 > 7700 and 1400 < 1600 therefore there are no outliers		A1
			(3)
	Notes		**Total 9**
(a)	M1 for a correct method to find $\bar{x}$ or $\sum l$ Allow 45.8 or better. Ignore labels		
	M1 for a correct method to find $\bar{l}$ ft their $\bar{x}$ if it is clearly labelled or it comes from $\frac{3711}{81}$ or ft their $\sum l$ if it is clearly labelled or comes from $3711+81\times 600$		
	A1 awrt 646 or $\frac{17437}{27}$ or $\frac{52311}{81}$ oe		
(b)	M1 correct method to find Var (X) implied by awrt 3770 or a correct method to find Var (L) ft their $\sum l$ or Allow calculation of sd$\left[\sigma_x\right]$ = awrt 61.4 Ignore labels		
	A1 awrt 3770 labelled clearly as Var(L) or Var (L) = Var(X) or $\sigma_l = \sigma_x$ stated or variance is not changed by coding is stated or they have gained the answer from $\frac{34088381}{81}-\left(\frac{"52311"}{81}\right)^2$		
(c)	B1 cao		
(d)	M1 correct method to find IQR. May be implied by a correct limit. NB $1.5\times(5400-3800)=2400$		
	M1 for a correct method to find the upper or the lower outlier boundary.		
	A1 both 7800 and 1400 correct **and** 7700 and 1600 (as the minimum not IQR) seen **and** explicitly stating **no outliers**		

Qu	Scheme	Marks
4(a)		B1B1
		(2)
(b)	$0.3\times"0.98"$	M1
	$= 0.294$	A1
		(2)
(c)	$(0.3\times0.02)+("0.45"\times"0.04")+("0.25"\times"0.06")$	M1
	$= 0.039$	A1
		(2)
(d)	$P(C\|Red)=\dfrac{"0.25"\times"0.06"}{"0.039"}\left[=\dfrac{0.015}{"0.039"}\right]$	M1,M1
	$= 0.3846\ldots$ or $\dfrac{5}{13}$	A1
		(3)
	Notes	**Total 9**
(a)	B1 for 0.45, 0.25 and 0.98 Allow fractions	
	B1 0.04, 0.96 and 0.06, 0.94 Allow fractions	
(b)	M1 may ft their tree diagram if method shown 0.3 × " their 0.98"	
	A1 0.294 oe	
(c)	M1 may ft their tree diagram if method shown	
	A1 0.039 oe	
(d)	M1 allow $\dfrac{p}{"\text{their part (c)}"}$ or $\dfrac{p}{0.039}$ where $0 < p < 1$ and $p <$ denominator and their (c) is a probability or allow $\dfrac{"0.25"\times"0.06"}{q}$ or $\dfrac{0.015}{q}$ where $0 < q < 1$ and $q >$ numerator	
	M1 for $\dfrac{"0.25"\times"0.06"}{"0.039"}$ ft their tree diagram and their part(c) if all 3 figures shown in working. We will condone num > denom	
	A1 awrt 0.385	
	NB if correct ft on numerator and denominator leads to "num" > "denom" then max score is M0M1A0	

Qu	Scheme	Marks
5(a)	$P(Y=y)$ | $2k$ | k | k | $8k$ | $17k$ | k	M1
	$2k+k+k+8k+17k+k=1$ or $30k=1$ $\left[\Rightarrow k=\frac{1}{30}\right]$*	A1*
		(2)
(b)	$k+k+8k$ or $1-(2k+17k+k)$	M1
	$=\frac{1}{3}$ **oe** **awrt 0.333**	A1
		(2)
(c)	$(1\times 2k)+(2\times k)+(3\times k)+(4\times 8k)+(5\times 17k)+(6\times k)$ =	M1
	$\frac{13}{3}$ oe **awrt 4.33**	A1
		(2)
(d)	$P(Y\geqslant 15-2Y)$ or [X =] 13 11 9 7 5 3 only or [Y =] 5 or 6 only	M1
	$[P(Y\geqslant 5) = P(Y=5)+P(Y=6)] = \frac{"17"}{30}+\frac{"1"}{30}$	M1
	$= \frac{3}{5}$ oe	A1ft
		(3)
(e)	Var (X) = 4Var(Y)	M1
	$[E(Y^2)=](1\times 2k)+(2^2\times k)+(3^2\times k)+(4^2\times 8k)+(5^2\times 17k)+(6^2\times k)\left[=\frac{302}{15}\text{ or awrt } 20.1\right]$	M1
	$[\text{Var}(Y)=]"\frac{302}{15}"-\left("\frac{13}{3}"\right)^2\left[=\frac{61}{45}\text{ or awrt } 1.36\right]$	M1d
	$[\text{Var}(X)=]$ $\frac{244}{45}$ oe **awrt 5.42**	A1
	ALT for 1st 3 marks	(4)
	$[E(X)=]$ $(13\times 2k)+(11\times k)+(9\times k)+(7\times 8k)+(5\times 17k)+(3\times k)\left[=\frac{19}{3}\text{ or awrt } 6.33\right]$	M1
	$[E(X^2)=](13^2\times 2k)+(11^2\times k)+(9^2\times k)+(7^2\times 8k)+(5^2\times 17k)+(3^2\times k)\left[=\frac{683}{15}\text{ or awrt } 45.5\right]$	M1
	$[\text{Var}(X)=]"\frac{683}{15}"-\left("\frac{190}{30}"\right)^2$	M1d
	Notes	**Total 13**
(a)	M1 for finding the probabilities in terms of k. The individual probabilities must be seen either in a table or in the calculation (but do not need to be simplified)	
	A1* Method mark must be awarded. For a correct equation which would lead to $k=1/30$ *	
	NB Verification - $2\left(\frac{1}{30}\right)+\left(\frac{1}{30}\right)+\left(\frac{1}{30}\right)+8\left(\frac{1}{30}\right)+17\left(\frac{1}{30}\right)+\left(\frac{1}{30}\right)=1$ gains M1 A0	
(b)	M1 for using $P(Y=2)+P(Y=3)+P(Y=4)$ or $1-P(Y=1)+P(Y=5)+P(Y=6)$ Allow in terms of k or with $k=1/30$ subst or with their probabilities. Do not allow in terms of y	
	A1 awrt 0.333	
(c)	M1 for using $\sum xP(x)$ At least 3 terms given Allow with $k=1/30$ subst or ft their probabilities.	
	A1 awrt 4.33	
(d)	M1 forming correct inequality in Y **or** 13,11,9,7,5,3 seen anywhere **or** for 5 and 6 only. Implied by 2nd M1	
	M1 finding their $P(Y=5)$ + their $P(Y=6)$ or $P(X=5)+P(X=3)$ eg $17k + k$	
	A1ft ft their probabilities	
(e)	M1 written or used 4Var(Y) (may come at the end of the calculation) or written or used E(X) allow awrt 6.33 **NB** condone -2^2Var(Y) if used 4Var(Y)	
	M1 Correct method, at least 3 products correct, to find $E(Y^2)$ or $E(X^2)$ condone incorrect labels	
	M1d dep on the 2nd M mark being awarded. For correct use of $E(Y^2)-[E(Y)]^2$ or $E(X^2)-[E(X)]^2$ For the **ALT** In addition to the 2nd M1 the 1st M1 must be awarded. Condone incorrect labelling	
	A1 awrt 5.42	

Qu	Scheme	Marks
6(a)	0.6	B1
		(1)
(b)	$\left[\mathrm{P}(A\cap B)=\right]0.1\times0.3$ **or** $0.3=\dfrac{\mathrm{P}(A\cap B)}{0.1}$	M1
	$0.25=0.1+\mathrm{P}(B)-\text{"0.03"}$ **or** $0.25=0.1+\mathrm{P}(B)-\mathrm{P}(A\cap B)$	M1
	$0.25=0.1+\mathrm{P}(B)-0.03$ **or** $0.3=\dfrac{\mathrm{P}(B)-0.15}{0.1}$ $\therefore$ P(B) = 0.18*	A1*
		(3)
(c)	 	M1 M1 B1ft B1ft A1
		(5)
	Notes	**Total 9**
(a)	B1cao	
(b)	M1 for use of $\mathrm{P}(B\mid A)=\dfrac{\mathrm{P}(A\cap B)}{P(A)}$ with 0.1 and 0.3 substituted. Allow for 0.1×0.3 seen	
	M1 $0.25=0.1+\mathrm{P}(B)-p$ where $0<p<1$ or $p=\mathrm{P}(A\cap B)$ oe eg $0.25-0.1+p=\mathrm{P}(B)$ (allow any letter for P(B))	
	A1* P(B) = 0.18 depends on both previous M marks for a fully correct equation in terms of P(B) (allow any letter for P(B)) followed by P(B) = 0.18	
	NB 0.03 used/stated with no working could get M0M1A0 Using $\mathrm{P}(A\cap B)=0.1\times\mathrm{P}(B)$ then they get M0M0A0 **Verification** could get M1M1A0 M1 for 0.1×0.3 M1 for $0.25-0.18-0.1=-0.03$ or $0.3=\dfrac{0.18-0.15}{0.1}$ or $0.25=0.1+0.18-\mathrm{P}(A\cap B)$	
(c)	M1 for 3 circles as per either diagram. If using Diagram 2 we must see exactly 2 zeros in one of the intersections (as shaded). (**Do Not** accept blank or dash instead of 0) Condone missing rectangle. Ignore labels	
	M1 for 0.09 and 0.41 marked correctly in diagram – condone incorrect/no label but must be in the left or right hand circles in 1st diagram or must have zeros (condone blank or dash) in the 2 other regions of the circle if in 2nd diagram	
	B1ft their "0.03" in correct place on diagram. Correct label required	
	B1ft for 0.34 or ft 0.75 – "their 0.41" where their $0.41\neq0.5$ No other ft accepted. Do not allow 0.75	
	A1 fully correct Venn diagram including the rectangle and all 3 labels.	
	SC no labels could get M1M1B0B1A0 if using 3 intersecting circles must have blanks or 0 for the 2nd M1	

Qu	Scheme	Marks
7(a)(i)	$P(J > 510) = P\left(Z > \frac{510-500}{25}\right)$ or P(Z > 0.4)	M1
	$= 1 - 0.6554 \Rightarrow 0.3446$ *	A1*
		(2)
(ii)	$\frac{d-500}{25} = -1.4$ (calc –1.3997…)	M1B1
	$d = 465$ (calc 465.007)	dA1
		(3)
(b)	$(1-0.3446)^5$	M1
	$= 0.1209\ldots$ **awrt 0.121**	A1
		(2)
(c)	$\frac{r-520}{k} = -1.0364$	M1A1
	$\frac{3r-800-520}{k} = 2.5758$	M1A1
	$-240 = (3\times -"1.0364k") - "2.5758"k$ or $\frac{r-520}{"-1.0364"} = \frac{3r-1320}{"2.5758"}$ oe	ddM1
	$k = 42.216...$ **awrt 42**	A1
	$r = 476.246...$ **awrt 476**	dA1
		(7)
	Notes	**Total 14**
(a)(i)	M1 for standardising using 500 and 25. Allow for 0.4	
	A1* M1 must be awarded. For 1 – 0.6554 = 0.3446 or using calc 0.34457… = 0.3446 or better	
(ii)	M1 correct standardisation using 500 and 25 equated to a *z* value where $1 < \lvert z \rvert < 2$	
	B1 correct expression with compatible signs eg $\frac{500-d}{25} = 1.4$ (calc 1.3997…) or allow incompatible signs with $500-("535"-500)$ **SC** $\frac{510-d}{25} = 1.4$ (calc 1.3997…) can get M0B1A0	
	dA1 dependent on M1 awarded for 465 or 465.007...	
(b)	M1 for $(p)^5$ where $0 < p < 1$	
	A1 awrt 0.121	
(c)	M1 $\frac{r-520}{k}$ = *z* value where |*z*| > 1	
	1st A1 $\frac{r-520}{k}$ = awrt -1.0364 (calc $1.036433...$) (signs must be compatible)	
	2nd M1 $\frac{3r-800-520}{k}$ = *z* value where |*z*| > 2	
	2nd A1 $\frac{3r-800-520}{k}$ = awrt 2.5758 (calc 2.5758293…) (signs must be compatible)	
	3rd M1 (dep on both Ms) for forming a correct equation in *k* or *r* only **using their *z* values**. ISW once correct equation seen eg –5.685*k* = –240 or $\frac{3(-1.0364k+520)-800-520}{k} = 2.5758$ Implied by *r* **and** *k* correct	
	3rdA1 for awrt 42	
	4th A1 for awrt 476 Must come from equations with **compatible signs**	
	NB awrt 476 and awrt 42 does not mean full marks. They could get M1A0M1A0 M1A1A1 if they do not have accurate *z* values	

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