

Question	Working	Answer	Mark	Notes
13		$p = 15$	3	B1 cao
	$-5 - 2p$ or $-5 - 2 \times "15"$ or $-5b - 2pb = qb$ or $2p + q = -5$ oe			M1 compare coefficients of <b>b</b> Allow one sign error in $-5 - 2p$ eg $-5 + 2p$ or allow ft of their $p$ value and one sign error ie $5 - 2 \times "15"$ or $-5 + 2 \times "15"$ or $-5b + 2pb = qb$ or $5b - 2pb = qb$ or $-5b - 2pb = -qb$ oe Allow $p = "15"$ subst
	Correct answer scores full marks (unless from obvious incorrect working)	$q = -35$		A1
				SC if $p$ and $q$ are correct but not written on the answer line, at least one must be labelled in their working to award full marks. If both values are correct but neither labelled or they are on the wrong answer lines they get 2/3 marks
				Total 3 marks

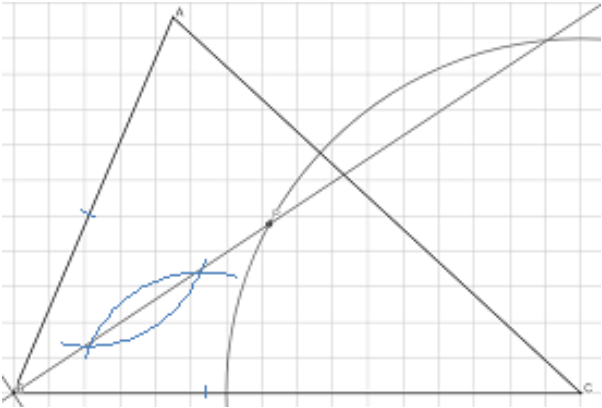
Question	Working	Answer	Mark	Notes
14	(a)	$0.07y$	1	B1 cao oe $\left(\frac{7}{100}y\right)$
	(b)	number bottle $B = 0.12y$ increase = $0.05y$ or 5%	1	M1 for sight of $0.12y$ or $\frac{12}{100}y$ or $0.05y$ or $\frac{5}{100}y$ or 5% 12%–7% or $12\%y - 7\%y$
		$0.12y - "0.07y" = 60$ or $0.05y = 60$ or $60 \div 5 \times 100$ or $5\% = 60$ or $5\%y = 60$ or $12\% - 7\% = 60$ or $12\%y - 7\%y = 60$	1	M1 oe follow through their result from part (a)
		1200	1	A1 cao Must come from a correct equation Correct answer with no working gains full marks
				Total 4 marks

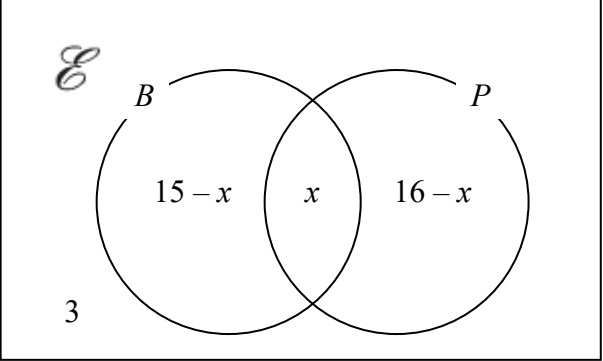
Question	Working	Answer	Mark	Notes
15	$\begin{array}{rcl} 20x + 7y = 4 & 40x + 14y = 8 \\ \underline{20x - 20y = -50} & \underline{14x - 14y = -35} \\ 27y = 54 & 54x = -27 \end{array}$ <p>or</p> $20\left(\frac{2y-5}{2}\right) + 7y = 4 \text{ or}$ $20x + 7\left(\frac{2x+5}{2}\right) = 4 \text{ or}$ $2\left(\frac{4-7y}{20}\right) - 2y = -5 \text{ or}$ $2x - 2\left(\frac{4-20x}{7}\right) = -5 \text{ oe}$		4	<p>M1 eliminating either <math>x</math> or <math>y</math> (equate coefficient and use correct operation) Allow 1 error either one incorrect term in equating the coefficients eg <math>-4</math> instead of <math>8</math> <b>or</b> one error when eliminating either <math>x</math> or <math>y</math></p> <p><b>or</b></p> <p>substitute for <math>x</math> or <math>y</math> to form an equation in only one variable. Allow 1 sign slip only</p>
		$x = -\frac{1}{2} \text{ or}$ $y = 2$		A1 dep on M1
	$20 \times "-\frac{1}{2}" + 7y = 4 \text{ or}$ $20x + 7 \times "2" = 4 \text{ or}$ $2 \times "-\frac{1}{2}" - 2y = -5 \text{ or}$ $2x - 2 \times "2" = -5 \text{ oe}$			<p>M1dep on previous method mark</p> <p>For repeating first method (allow one sign error) or substitute their <math>x</math> or <math>y</math> into a correct equation</p>
	<i>Working required</i>	$x = -\frac{1}{2}$ <p>and <math>y = 2</math></p>		A1 dep on M1 M1
				<b>Total 4 marks</b>

Question	Working	Answer	Mark	Notes
16	Let $t$ = total number of students and $c$ = number of students who travel by car Allow any letters for $t$ and $c$			
	$[t =] \frac{208}{0.104}$ or $[t =] 718 + 0.896t - 510$ or $\frac{208}{208 + 510 + c} = 0.104$ or $[c =] \frac{208}{0.104} - 208 - 510$ or $[c =] 0.896 \times \frac{208}{0.104} - 510$ or $[c =] \frac{208}{0.104} - 718$ or $0.896 \times (718 + c) = 510 + c$ or $\frac{510}{208} \times 10.4$		4	M1 correct method to find $t$ or $c$ or correct equation (any form) in terms of $t$ or $c$ or correct method to find the % that represents 510 students May be implied by seeing 25.5 or 1282 or 2000
	$[t =] 2000$ or $[c =] 1282$ or 25.5			A1 correct value for $t$ or $c$ or percentage
	$\frac{"1282"}{2000} \times 100$ or $\frac{"1282"}{"1282" + 208 + 510} \times 100$ or $\frac{1282}{"2000"} \times 100$ or $100 - 10.4 - "25.5"$ or $100 - 10.4 - \frac{510}{"2000"} \times 100$			M1 For an attempt at a correct method to find the percentage. Allow $\frac{n}{2000} \times 100$ or $\frac{n}{n + 718} \times 100$ where $n < 2000$ or $\frac{1282}{m} \times 100$ where $m > 1282$ or $\frac{r - 718}{r} \times 100$ where $r > 718$ or $100 - 10.4 - \frac{510}{"p"} \times 100$ where $p > 510$ or $100 - 10.4 - q$ where $20 < q < 30$ may be implied by 64.1 Condone rounded figures.
	Correct answer scores full marks (unless from obvious incorrect working)	64.1		A1 cao Allow 64 Do <b>not</b> ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining.
				Total 4 marks

Question		Working	Answer	Mark	Notes	
17	(a)	eg $\frac{16.1}{48}$ [= 0.335] or $\frac{1610}{48}$ or $\frac{16.1}{12\cancel{25}} \text{ or } \frac{x}{16.1} = \frac{1}{48} \text{ or } \frac{x}{1610} = \frac{1}{48}$ or $\frac{x}{16.1} = \frac{25}{12}$ oe		2	M1 correct method or equation to find length in m or cm. Implied by 0.335	
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	33.5		A1 awrt 33.5	
	(b)	$48^3$ [= 110 592] or $0.48^3$ [= 0.110 592]		3	M1 Consideration of cube of scale factor seen. eg $\left(\frac{16.1}{(a)}\right)^3$ or $\left(\frac{1610}{(a)}\right)^3$ or $\frac{995}{V} = \frac{(a)^3}{1610^3}$	M2 for $\frac{995}{100^3} \times 48^3$
		$\frac{995}{100^3}$ [= 0.000995] or [995×"110 592"]÷100 <sup>3</sup> $0.48^3$ [= 0.110 592]			M1 for unit conversion by dividing by 100 <sup>3</sup>	
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	110		A1 awrt 110	
					<i>Total 5 marks</i>	

Question		Working	Answer	Mark	Notes
18			angle bisector constructed accurately	4	B2 for a line within the limits and a pair of suitable arcs. One arc centred on a point $D$ on $BC$ and one centred on the point $E$ on $AB$ such that $BE = BD$ <b>or</b> 2 arcs centred at $B$ with the cross to find the middle. (B1 for a line within the limits (Can be any length - does not need to cross $AC$ but should remain within the guidelines if it were to be extended) <b>or</b> a pair of suitable arcs
			Accurate arc drawn from $C$		B1 for an arc within the limits indicated. It does not need to cross $AC$ or $BC$
			$P$ correctly labelled		B1ft dependent on at least B1 for the angle bisector and B1 for the arc. Must clearly identify it is the point.
					<b>Total 4 marks</b>



Question		Working	Answer	Mark	Notes
19	(a)			2	<p>B2 <math>15 - x</math>, <math>16 - x</math> and 3 in correct regions on Venn diagram</p> <p>B1 2 of <math>15 - x</math>, <math>16 - x</math> and 3 in correct regions or all 3 values correct, one in correct region.</p> <p>Allow 11 for <math>15 - x</math> and 12 for <math>16 - x</math></p> <p><b>SC</b> B1 <math>x</math> is replaced with a number <math>x \neq 4</math> and they use this incorrect value, to find <math>15 - x</math> and <math>16 - x</math></p>
	(b)	$3 + "15 - x" + x + "16 - x" = 30$ oe		2	<p>M1 Correct equation formed, in <math>x</math>, ft their values for <math>B' \cap P</math> and <math>B \cap P'</math> May see only one of these values used eg <math>3 + 15 + "16 - x" = 30</math></p>
		Correct answer scores full marks (unless from obvious incorrect working)	4		A1 cao
	(c)		$\frac{11}{30}$	1	<p>B1 ft follow through their answer to part (b), if <math>0 &lt; \text{part(b)} &lt; 15</math> only ie <math>\frac{15 - "their(b)"}{30}</math> with numerator a single number. Allow awrt 0.367</p>
					Total 5 marks

Question	Working	Answer	Mark	Notes
20	Throughout this question condone mis-labelling. eg if they label the volume of the cone as being the hemisphere			
	$\frac{2}{3}\pi \times 10^3 \left[ = \frac{2000\pi}{3} = 2094.395... \right]$		5	M1 Allow for $\frac{4}{3}\pi \times 10^3 \left[ = \frac{4000\pi}{3} = 4188.790... \right]$  Allow sight of 4189, awrt 4190 or awrt 2090 or exact fraction May be embedded within other working. Ignore labelling
	$\frac{1}{3}\pi \times 10^2 x \left[ = \frac{100\pi}{3} x = 104.719...x \right]$			M1 or $\frac{1}{3}\pi 10^2 (h-10)$ Allow sight of 104, awrt 105 or exact fraction.  Allow any letter for x. (Condone h for x) Ignore labelling
	$\frac{1}{3}\pi \times 10^2 x = \frac{3}{4} \times \left( \frac{2}{3}\pi \times 10^3 \right)$ or " $\frac{100\pi}{3}$ " $x = \frac{3}{4} \times \left( \frac{2000\pi}{3} \right)$ or $\frac{\frac{1}{3}\pi \times 10^2 x}{\frac{2}{3}\pi \times 10^3} = \frac{3}{4}$ oe			M1 using $V_{\text{cone}} = \frac{3}{4} \times V_{\text{hemisphere}}$ oe with at least one of the volumes correct Allow $h - 10$ or any letter for x (condone h) You may ft their values eg " $2094$ " $x = \frac{3}{4} \times \text{"105"}$ <b>NB</b> $x = 15$ <b>NB useful number</b> $\frac{3}{4} \times \left( \frac{2}{3}\pi \times 10^3 \right) = 1570.795...$
	"15"+10			M1 For using $h - 10$ anywhere <b>OR</b> if all 3 previous method marks awarded allow for "their x" + 10
	Correct answer scores full marks (unless from obvious incorrect working)	25		A1 awrt 25
	<b>SC</b> $r = 10$ not substituted could get <b>M1 M1 M0 M1 A0</b> 1 <sup>st</sup> M1 for $\frac{\frac{1}{3}\pi r^2 x}{\frac{2}{3}\pi r^3 x} = \frac{3}{4}$ (allow sphere)    2 <sup>nd</sup> M1 $\frac{x}{2 \times r} = \frac{3}{4}$ or $\frac{x}{4 \times r} = \frac{3}{4}$ 4 <sup>th</sup> M1 for using $h - 10$ or adding 10 A0			
				<b>Total 5 marks</b>

Question		Working	Answer	Mark	Notes	
21	(a)	$[AG^2 = ]12^2 + 4^2 (=160)$ or $[AC^2 = ]12^2 + 3^2 (=153)$ or $[AE^2 = ]4^2 + 3^2 (=25)$		3	M1 A correct method to find $AG^2$ , $AC^2$ , $AE^2$ , $AG$ , $AC$ or $AE$ . Allow use of trig but must be fully correct method eg $[\angle GAB = ]\tan^{-1}\left(\frac{4}{12}\right)[=18.434....]$ <b>and</b> $[AG = ]\frac{12}{\cos"18.434..."}$ Ignore incorrect labels labels	M2 for $[AF^2 = ]3^2 + 12^2 + 4^2$
		$[AF^2 = ]3^2 + "160"$ or $3^2 + ("4\sqrt{10}")^2$ $[AF^2 = ]4^2 + "153"$ or $4^2 + ("3\sqrt{17}")^2$ $[AF^2 = ]12^2 + "25"$ or $[AF^2 = ]169$			M1 full method to find $AF^2$ For this mark allow values correct to 3sf. but condone truncation eg $4^2 + (\text{awrt } 12.3)^2$ or $3^2 + (\text{awrt } 12.64)^2$ Ignore incorrect labels <b>NB</b> $\sqrt{160} = 12.649...$ $\sqrt{153} = 12.369...$	
		Working required	13		A1 dependedent on both method marks awarded. For a full method to find $AF$ with no incorrect working seen and 13 stated Must see 169 or a correct expression for $AF^2$ with exact values used.	
		(b)	$\sin GAF = \frac{3}{"13"}$ or $\tan GAF = \frac{3}{"\sqrt{160}"}$  or $\cos GAF = \frac{"\sqrt{160}"}{"13"}$ oe		2	M1 A correct method to find $\angle GAF$ or trig ratio of $\angle GAF$ May ft values from part (a) including their $AF$ if it is not 13 if it is clearly labelled or comes from a correct calculation  Allow ( $\tan AFG = \frac{\sqrt{160}}{3}$ <b>or</b> $\sin AFG = \frac{\sqrt{160}}{13}$ <b>or</b> $\cos AFG = \frac{3}{13}$ ) <b>and</b>  $90 - \angle AFG$  Allow use of cosine or sine rule eg $3^2 = 160 + 13^2 - 2 \times \sqrt{160} \times 13 \cos GAF$
	Correct answer scores full marks (unless from obvious incorrect working)		13.3	A1 awrt 13.3 Allow awrt 13.4		
						Total 5 marks



Question	Working	Answer	Mark	Notes
22	$(-k)^3 + 4(-k)^2 - 20(-k) - (-k) [= 0]_{\text{or}}$ $-k^3 + 4k^2 + 20k + k [= 0]_{\text{oe}}$		5	<p>M1 substitutes <math>x = -k</math> Allow 1 sign error if brackets removed or  long division to obtain 2 correct terms <math>x^2 + (4 - k)x + (-20 - 4k + k^2)</math>  or two of 1 <b>or</b> <math>4 - k</math> <b>or</b> <math>-20k - 4k + k^2</math>  attempt to expand <math>(x + k)(x^2 + gx + 1)</math> with at least 4 out of 6 terms  correct cubic is <math>x^3 + kx^2 + gx^2 + gkx + x + k</math> oe</p>
	$-k^3 + 4k^2 + 21k = 0$ or $-20 - 4k + k^2 = 1$ or $k + g = 4$ and $1 + kg = -20$ oe			<p>A1 correct simplified 3 term cubic equation or a correct quadratic equation or both correct equations from comparing <math>x^2</math> and <math>x</math> coefficients.</p>
	$(k)(-k^2 + 4k + 21) = 0$ or $k^2 - 4k - 21 = 0$ oe			<p>M1 dep on first M mark. Divide by or take <math>k</math> out as a common factor from a cubic in <math>k</math> to form a 3-term quadratic equation. An answer of 7 or <math>-3</math> can imply this mark</p>
	$(k)(-k + 7)(k + 3) = 0$ or $(k - 7)(k + 3) = 0$			<p>M1 dep on second M mark. Correct method for solving their 3-term quadratic – either by formula, completing the square or factorising.  By factorising: brackets must expand to give 2 out of 3 correct terms  By formula: correct substitution into fully correct formula (allow 1 sign error)  By completing the square: must see <math>(k - 2)^2 \pm \dots</math>  An answer of 7 or <math>-3</math> can imply this mark</p>
	<i>Correct answer scores full marks  (unless from obvious incorrect  working)</i>	7, -3		<p>A1 cao (both) condone 0, 7, <math>-3</math> but do not allow any other incorrect extras</p>
				<b>Total 5 marks</b>

Question	Working	Answer	Mark	Notes
23	(a)	$[ON^2 = ]19.5^2 - 18^2$ or $19.5^2 = ON^2 + 18^2$ or $39^2 - 36^2$ or $[ON = ]19.5 \cos(67.3801\dots)$ or $[ON = ]19.5 \sin(22.6198\dots)$ oe	2	M1 use of Pythagoras <b>or</b> trig seen – allow angles given to at least 3sf Allow $XD = \sqrt{39^2 - 36^2}$ where $BX$ is the diameter
		Working required	$\sqrt{19.5^2 - 18^2} = 7.5$	A1 allow $\sqrt{56.25} = 7.5$ or $19.5 \cos(67.3801\dots) = 7.5$ or $\frac{\sqrt{39^2 - 36^2}}{2}$ oe or $19.5 \sin(22.6198\dots) = 7.5$ or $ON^2 = 56.25 \Rightarrow ON = 7.5$ Allow angles given to 3sf
				<b>NB</b> verification using 7.5 is M0 A0
	(b)	$EN = 36 - 18 - 8 [= 10]$ <b>or</b> $EN = \frac{36}{2} - 8$ $AE \times EC = 8 \times 28$ <b>or</b> $AE \times EC = 224$ $\frac{AC}{2} + 7.5$ and $\frac{AC}{2} - 7.5$	4	M1 Find $EN$ either labelled or comes from correct working may be seen on diagram <b>or</b> $AE \times EC = 224$ or $AC/2 + 7.5$ and $AC/2 - 7.5$ identified as $AB$ and $BC$ or used in a formula. Allow $x + 7.5$ and $x - 7.5$ may be implied by the 2 <sup>nd</sup> M1
		$[AM^2 = ]19.5^2 - "10"'^2 [= 280.25]$ or  $\left(\frac{AC}{2} + 7.5\right)\left(\frac{AC}{2} - 7.5\right) = 8 \times 28$		M1 correct use of Pythagoras involving $AM$ where $M$ is the mid-point of $AC$ NB $AM = \sqrt{280.25} [= 16.7406\dots]$ ft their 10 if clearly labelled or comes from $36 - 18 - 8$ Correct use of intersecting chord theorem Allow $(x + 7.5)(x - 7.5) = 8 \times 28$
		$[AC] = 2 \times \sqrt{19.5^2 - "10"'^2}$ or $[AC = ]\frac{8 \times 28}{("16.7406\dots" + 7.5)} + ("16.7406\dots" + 7.5)$  $\left(\frac{AC}{2}\right)^2 = 224 + 7.5^2$ or		M1 dep on previous method marks awarded. For using $AC = 2 \times$ "their $AM$ " ft their 10 if clearly labelled or comes from $36 - 18 - 8$ or their awrt 16.7 if clearly labelled or comes from $\sqrt{19.5^2 - "10"'^2}$ find value for $\left(\frac{AC}{2}\right)^2$
		Correct answer scores full marks (unless from obvious incorrect working)	33.5	A1 awrt 33.5
				<b>Total 6 marks</b>

Question	Working	Answer	Mark	Notes
24	1.95 or 2.05 seen		6	B1
	$215[\times 1] + 362 \times 2 + 181 \times 3 +$ $94 \times 4 + 15 \times 5 [= 1933]$			M1 Find total number of children, at least 4 correct products seen added (215 + 724 + 543 + 376 + 75) or 1933 seen
	$\frac{"1933"}{867 + k} = 1.95$ <b>or</b> $\frac{"1933"}{1.95} - 867$ <b>or</b> $\frac{"1933"}{867 + k} = 2.05$ <b>or</b> $\frac{"1933"}{2.05} - 867$ <b>oe</b>			M1 for $\frac{"1933"}{867 + k} = b$ where $1.5 \leq b \leq 2.5$ <b>or</b> $\frac{"1933"}{b} - 867$ <b>oe</b> Allow < or > or $\leq$ or $\geq$ for = Allow equivalent <b>NB</b> $k + 215 + 362 + 181 + 94 + 15 \equiv k + 867$
	$\frac{"1933"}{867 + k_{\min}} = 1.95$ <b>or</b> $\frac{"1933"}{1.95} - 867$ <b>oe and</b> $\frac{"1933"}{867 + k_{\max}} = 2.05$ <b>or</b> $\frac{"1933"}{2.05} - 867$ <b>oe</b>			M1 Form two equations/expression for their mean. $\frac{"1933"}{867 + k} = b$ <b>or</b> $\frac{"1933"}{b} - 867$ where $1.95 \leq b < 2$ for one <b>and</b> $\frac{"1933"}{867 + k} = b$ <b>or</b> $\frac{"1933"}{b} - 867$ where $2 < b \leq 2.05$ for the other equation. Allow < or > or $\leq$ or $\geq$ for =
	$[k =] \frac{1933}{1.95} - 867 \left[ = \frac{4847}{39} \text{ or } 124.282... \right]$ <b>and</b> $[k =] \frac{1933}{2.05} - 867 \left[ = \frac{3113}{41} \text{ or } 75.926... \right]$			A1 both equations fully correct followed by awrt 124 and awrt 75.9 <b>or</b> for a fully correct expression for <b>both</b> values of $k$ seen allow 2.0499 for 2.05
		$76 \leq k \leq 124$		A1 The 3 <sup>rd</sup> M1 must be awarded. Allow [76, 124]
				<b>Total 6 marks</b>

Question		Working	Answer	Mark	Notes
25	(a)	$[AC]=\begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix}\begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix}$ or $[CA]=\begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix}\begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix}$ or $3 \times 2 - 1 \times 5$ or $3 \times 2 - (-1) \times (-5)$ or $6 - 5$		2	M1 for writing down either of the multiplications or the correct method shown to find the determinant of <b>A</b> or <b>C</b> .
		working must be shown	$\begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix}$ or $\begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix}$ or $\begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix}\begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ or $\begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix}\begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$		A1 for writing down an inverse or matrices multiplied = identity matrix
	(b) (i)		$\begin{pmatrix} 20 & 7 \\ 35 & 13 \end{pmatrix}$	2	B2 fully correct (B1 2 numbers correct) ignore order of matrices
	(ii)		$\begin{pmatrix} 5 & 1 \\ 5 & 4 \end{pmatrix}\begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix}$	1	B1 for seeing the matrices given in the correct order
	(c)	<b>AB = BA</b> or <b>C<sup>-1</sup>B = BC<sup>-1</sup></b>		2	M1 for either expression implied by a fully correct expression required for the A1 (no need to see <b>BC = CB</b> )
			<b>A<sup>-1</sup>ABA<sup>-1</sup> = A<sup>-1</sup>BAA<sup>-1</sup></b> or <b>CABC = CBAC</b> or <b>CC<sup>-1</sup>BC = CBC<sup>-1</sup>C</b> or <b>AC<sup>-1</sup>BA = ABC<sup>-1</sup>A</b> oe <b>followed by BC = CB</b>		A1 multiplies equation by <b>C</b> or <b>A<sup>-1</sup></b> both before and after (allow mixture) <b>AC = CA = I</b> and/or <b>C = A<sup>-1</sup></b> and/or <b>C<sup>-1</sup> = A</b> leading to correct equation
					<i>Total 7 marks</i>