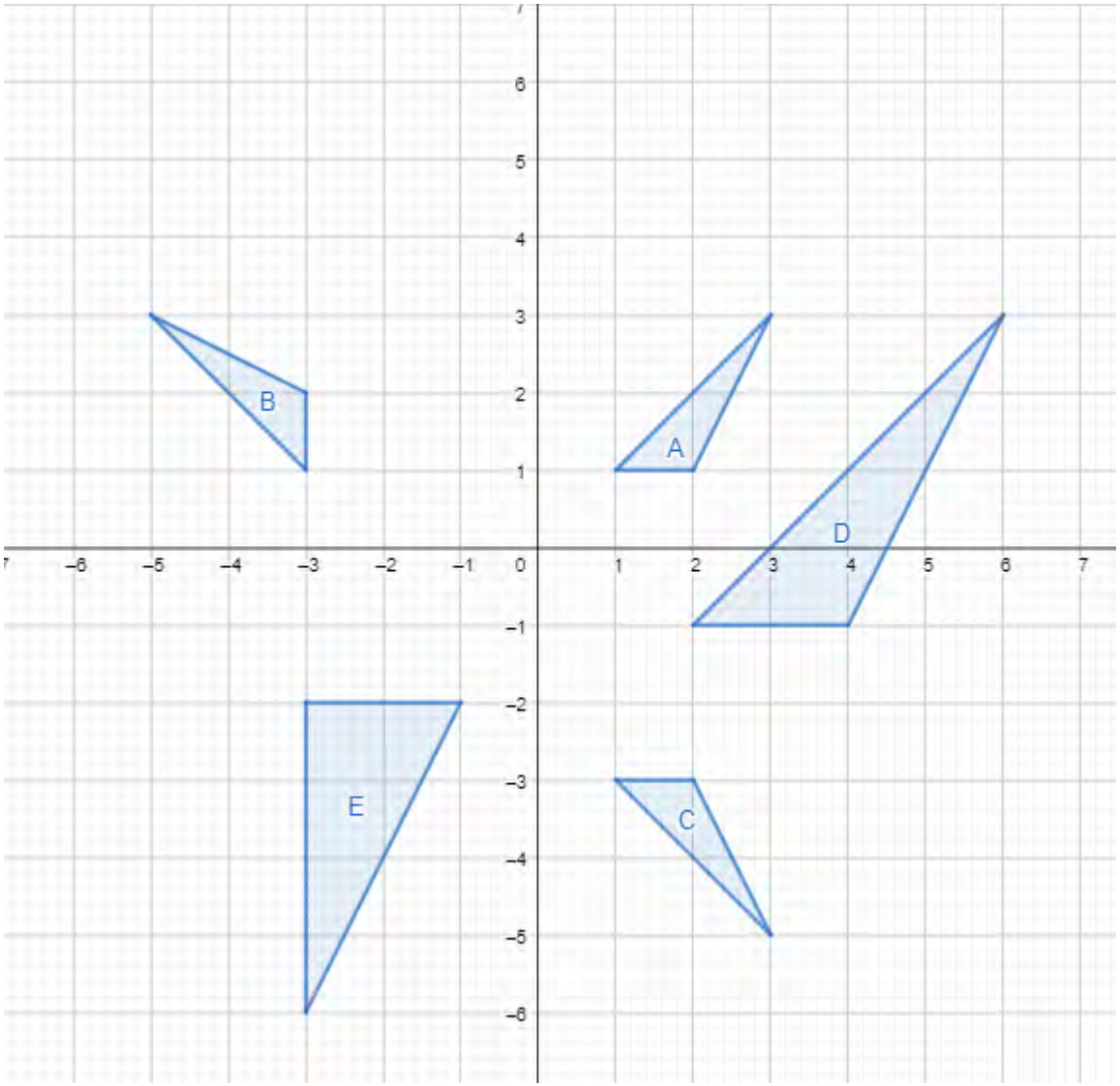
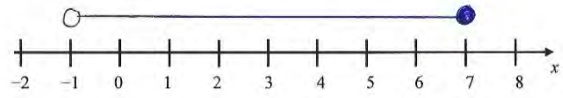
Question		Working	Answer	Mark	Notes
2	(a)	$\frac{4\times180-4\times125}{2}[=110]$ oe eg $\frac{(2\times6-4)\times90-4\times125}{2}[=110]$ or $360-2\times125[=110]$ oe eg $2\times(180-125)[=110]$ **or** $\frac{360-4\times(180-125)}{2}[=70]$ oe		5	M2 for correct method to find one of the unknown interior angles of the hexagon could use sum of interior angles or symmetry in the hexagon (eg line drawn from *C* to *L*) **or** for correct method to find the exterior angle (at *C* or *L*) of the hexagon can be implied by a correct calculation for *y* (If not M2 then M1 for: finding the angle sum of the hexagon eg 4 ×180 [= 720] or (2 × 6 – 4) × 90 [= 720] oe **or** finding one exterior angle of the hexagon eg 180 – 125 [= 55] **or** use of symmetry in the hexagon (eg line drawn from *C* to *L*) and finding *BCL* or *DCL* or *CLA* or *CLE* eg $\frac{360-2\times125}{2}[=55]$ or 180 – 125 [= 55]
		eg $\frac{(8-2)\times180}{8}[=135]$ oe eg $\frac{(2\times8-4)\times90}{8}[=135]$ **or** $\frac{360}{8}[=45]$			M1 for finding one interior angle of the octagon **or** for finding one exterior angle of the octagon can be implied by a correct calculation for *y*
		eg 360 – "110" – "135" **or** "70" + (180 – "135") **or** "70" + "45" **or** "45" + (180 – "110") oe			M1 (dep on all previous method marks awarded)
			115		A1 cao
	(b)	$10x + 25 + 7x – 83 = 180$ oe eg $17x – 58 = 180$		4	M1 for a correct equation in *x*
		$[x=]\frac{180+58}{17}$ [= 14]			M1 (dep on first method mark) for a correct expression for *x*
		$\frac{360}{7\times"14"-83}$ or $\frac{360}{180-(10\times"14"+25)}$			M1 ft dep on M1 ft their value of *x* provided *x* is from $\frac{180+58}{17}$ or clearly labelled as *x*
			24		A1 cao

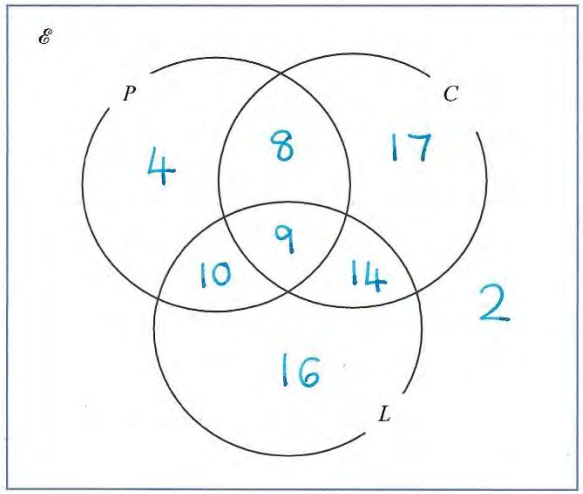
ALT	(b)	eg $T(7x-83)=360$ **and** $T(10x+25)=90(2T-4)$ oe eg $T(7x-83)=360$ **and** $T(10x+25)=180(T-2)$ or $7x-83=\frac{360}{T}$ **and** $10x+25=\frac{180(T-2)}{T}$			M1 for setting up two equations in x and T Allow the use of any letters for T and x provided they are not the same
		eg $7Tx=360+83T$ oe **and** $10Tx=90(2T-4)-25T$ oe eg $x=\frac{360+83T}{7T}$ oe **and** $x=\frac{90(2T-4)-25T}{10T}$ oe eg $70Tx=3600+830T$ oe **and** $70Tx=630(2T-4)-175T$ oe			M1 for making $7xT$ or x the subject of each equation or for coefficient of xT the same in both equations or for correct rearrangement of one equation followed by correct substitution into the other Allow the use of any letters for T and x provided they are not the same
		eg $1260T-175T-830T=3600+2520$ oe			M1 for collecting T terms on 1 side and numbers on the other in a correct equation Allow the use of any letters for T and x provided they are not the same
			24		A1 cao
		cas for each part			***Total 9 marks***

Question	Working	Answer	Mark	Notes
In this question ignore any (incorrect) labelling of triangles				
3 (a)		Rotation	3	B1 allow rotate, rotated, rotation do not accept turn B0 if multiple transformations stated. Multiple transformations are when more than one of reflection (mirrored), rotation (turn), translation (move), enlargement (stretch / squash) is stated eg a vector or SF or equation of a line do not imply multiple transformations
		90[°] [anticlockwise]		B1 oe eg 270 clockwise or –270 Do not allow 90 clockwise or –90 or –90 anticlockwise These two marks can still be awarded if multiple transformations are stated
		(–1, –1)		B1 must be a coordinate and not a vector Do not allow if another coordinate is given as well
(b)		Correct triangle *C* at (1, –3), (2, –3), (3, –5)	2	B2 Fully correct triangle. Award 2 marks for a correct triangle drawn, irrespective of working in the working space. (B1 for correct line drawn or a triangle of the correct size and orientation, or for 2 correct vertices plotted correctly or 3 correct vertices listed) SCB1 for triangle *B* reflected in the line $y = -1$ (vertices (–3,–3) (–3,–4) (–5,–5)) or for triangle *A* reflected in the line $x = -1$ (vertices (–4, 1) (–3, 1) (–5, 3))
(c)		Correct triangle *D* at (2, –1), (4, –1), (6, 3)	2	B2 Fully correct triangle. Award 2 marks for a correct triangle drawn, irrespective of working in the working space. (B1 for a triangle of the correct size and orientation, or for 2 correct vertices plotted correctly or 3 correct vertices listed)
(d)	Points can be in any order $\begin{pmatrix} -2 & 1 \\ 0 & -2 \end{pmatrix}\begin{pmatrix} 1 & 2 & 3 \\ 1 & 1 & 3 \end{pmatrix}$		3	M1 for intention to multiply the correct way, can be implied by writing the matrices in the correct order or correctly stating or plotting one point.
	Points can be in any order $\begin{pmatrix} -1 & -3 & -3 \\ -2 & -2 & -6 \end{pmatrix}$			M1 for at least two correct columns or correctly stating or plotting two points.
		Correct triangle *E* at (–1, –2), (–3, –2), (–3, –6)		A1 Fully correct triangle Award 3 marks for a correct triangle drawn, irrespective of working in the working space.
cas for each part				***Total 10 marks***


B
A
D
E
C

Question	Working	Answer	Mark	Notes
4(a)	$4x \leqslant 31-3$ oe or $x+\frac{3}{4} \leqslant \frac{31}{4}$		2	M1 for isolating the x term or reducing for x May be the wrong inequality sign or an = sign Also allow for a critical value of 7 with incorrect sign
		$x \leqslant 7$		A1oe eg $(-\infty, 7]$or $[-\infty, 7]$ do not isw $x = 7$
(b)		$-1 < x < 9$	2	B2 or other correct notation eg (–1, 9) or $-1 < x$, $x < 9$ or $-1 < x$ **and** $x < 9$ or $-1 < x \cap x < 9$ (B1 for one end correct or for "$-1 < x$ **or** $x < 9$")
(c)	A single line joining $x = -1$ and $x = 7$		2	M1 Do not allow lines with arrows at end points or identification of any other values
				A1 **Both** end points identified using the correct symbols **and** one correct line drawn between the two correct points
	cas for each part			***Total 6 marks***

Question	Working	Answer	Mark	Notes
5(a)		–3, 0, 9	2	B2 all values correct (B1 for 2 values correct)
(b)			2	M1 for at least 5 points plotted correctly ±1 small square **or** for at least 4 points plotted correctly ±1 small square and a smooth curve drawn through all their plotted points If you are unable to see the points plotted then allow if curve goes through them within/on the circles.
		Correct graph		A1 for fully correct graph ±1 small square. Do not allow straight line segments
(c)			2	M1 for the line $y = 2$ drawn on the grid that goes from at least $x = –1.5$ to $x = 1.3$ and intersects the curve at all points at which $y = 2$
		–1.7, 0.2, 1.5		A1 dep on M1 and M1 being awarded in part (b) (condone straight line segments for this part of the question) For all 3 values and no extras Allow –1.9 to –1.5 and 0 to 0.4 and 1.3 to 1.7 A0 if values are given to >2dp or if answers given as coordinates or y values given as well as x values or if answer is given as an inequality Do not isw so if –1.7, 0.2, 1.5 then $–1.7 < x < 1.5$ A0 For reference values from calc are $x = –1.672981648, 1.469617434, 0.2033642138$
	(a) *cas* (b) *cas* (c) *wr*			***Total 6 marks***

Question	Working	Answer	Mark	Notes
6 (a)		Correctly completed Venn diagram	3	B3 All 8 regions completed correctly (B2 for 5, 6 or 7 regions completed correctly (B1 for 3 or 4 regions completed correctly))
(b)		25	1	B1 ft from a diagram where values other than 0 are present in the required regions
(c)		$\frac{23}{48}$	2	B2 oe eg 0.47(91…) rounded or truncated to 2sf (B1 ft from a diagram where values other than 0 are present in the required regions for $\frac{23}{a}$ where $a > 23$ or $\frac{"9+14"}{a}$ or $\frac{"9+14"}{80} \div \frac{a}{80}$ (ft their 23) where $a >$ "9 + 14" or $\frac{b}{48}$ or $\frac{b}{80} \div \frac{48}{80}$ oe eg $\frac{b}{80} \div \frac{3}{5}$ where $b < 48$ or 23 : 48) B1 only for $\frac{9+14}{48}$
	cas for each part			***Total 6 marks***

Question	Working	Answer	Mark	Notes
7 (a)			2	M1 for at least 2 correct values in the correct places
		$\begin{pmatrix} 10 & -4 \\ -4 & 10 \end{pmatrix}$		A1 cao Do not isw
(b)			3	M2 for a matrix of the correct order and at least 4 correct values in the correct places (M1 for a matrix of the correct order and at least 2 correct values in the correct places)
		$\begin{pmatrix} -2 & -6 & 22 \\ 2 & 4 & -18 \end{pmatrix}$		A1 cao Do not isw
(c)	$10\times5-(-6\times-8)[=2]$		4	M1 a correct method to find the determinant of **A** can be implied by multiplying matrix **A** by ½
	$\frac{1}{2}\begin{pmatrix} 5 & 6 \\ 8 & 10 \end{pmatrix}$			M2 for 4 values in the correct places in their $\mathbf{A^{-1}}$ (M1 for at least 2 correct values in the correct places in their $\mathbf{A^{-1}}$)
	$\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}-\begin{pmatrix} 2.5 & 3 \\ 4 & 5 \end{pmatrix}$	$\begin{pmatrix} -0.5 & -3 \\ -4 & -3 \end{pmatrix}$		A1 cao
	cas for each part			***Total 9 marks***

Question	Working	Answer	Mark	Notes
8 (a)		15, 15, 16, x, 22	3	M1 for a list of 5 numbers where the mode is 15 or the median is 16 or the range is 7
				M1 for a list of 5 numbers with two of: the mode is 15 the median is 16 the range is 7
				A1 where x is 17, 18, 19, 20 or 21 (numbers can be in any order)
(b)	8 × 104 [= 832] or 5 × 89 [= 445]		3	M1 for the total weight of the 8 letters or the total weight of the 5 letters
	8 × 104 – 5 × 89 oe eg "832" –"445" [= 387]			M1 for the total weight of the 3 letters
		129		A1 cao
(c)	<u>cm square (5ss by 5ss)</u> $1\times3+3\times4$ cm squares = 75 or 15 cm squares = 75 or 1 cm square = 5 parcels oe <u>small squares (ss)</u> 75 lines of 5 ss = 75 or $5\times15+15\times20$ ss = 75 or 375 ss = 75 or 5 ss = 1 parcel oe		5	M1 for showing frequency is related to area by a correct calculation or a correct value for area and frequency or a correct value on FD axis (1 cm vertically is FD 5) this may come from $1\times15x+3\times20x=75$ oe eg $1\times3x+3\times4x=75$ Implied by a frequency of 20 or 15 or 60 or 30 or 20 seen Any fd / frequency may be seen in the correct place on the histogram
	<u>using FD</u> eg 2 × 10 + 75 + 2 × 15 + 4 × 5 [= 145] 2 × 20 + 2 × 15 + 4 × 5 [= 90] <u>cm square (5ss by 5ss)</u> eg 14 × "5" + 75 [= 145] or 29 × "5" [= 145] oe or 18 × "5" [= 90] <u>small squares (ss)</u> eg $\frac{100+75+300+150+100}{5}$ [= 145] $\frac{200+150+100}{5}$ [= 90]			M1 implies the previous method mark for a correct method to find the total number of parcels or a correct method to find the number of parcels greater than 4 kg Also allow correct method to find the number of parcels less than 4 kg eg 2 × 10 + 1 × 15 + 1 × 20 [= 55] oe
	"$\frac{90}{145}$" or "$\frac{18}{29}$" or "0.62(06...)" oe			M1 implies both previous method marks for a correct first probability Only ft numbers from correct working Also allow the correct probability for a parcel being less than 4 kg eg $\frac{55}{145}$ or $\frac{11}{29}$ or 0.37(93...)

	$\frac{90}{145}\times\frac{90-1}{145-1}$ oe			M1 A correct product Allow $\left(\frac{90}{145}\right)^2=\frac{324}{841}\approx 0.385$ Condone $2\times\frac{90}{145}\times\frac{90-1}{145-1}$ and $2\times\left(\frac{90}{145}\right)^2$
		$\frac{89}{232}$		A1 oe eg 0.38(36…) [decimal or % 2sf or better] Allow 0.38 – 0.3853
	cas for each part			***Total 11 marks***

Question	Working	Answer	Mark	Notes
9 (a) (i)		80	1	B1 cao
(a) (ii)		correct reason	1	B1 dep on B1 in (i) for Angle at the centre is 2 × (double) angle at circumference / angle at circumference is ½ angle at centre allow the symbol for the word 'angle'
(b)	eg "80" – 37 or 360 –"80" – 37 – (360 – 160) or 180 –"80" – 37 – (180 – 160) oe		2	M1 ft their answer to part (a)(i) A correct method to find angle *TPO*
		43		A1 cao
(c)	**Throughout part (c) allow 3.1, 3.14, etc or $\frac{22}{7}$ for π and allow any letter or symbol for *r***			
(c)	$\frac{160}{360}\times\pi\times r^2=\frac{196}{25}\pi$ oe eg $\frac{160}{360}\times r^2=\frac{196}{25}$		6	M1 for an equation in the form $\frac{160}{360}\times\pi\times(...r)^2=\frac{196}{25}\pi$ or $\frac{160}{360}\times\pi\times...r^2=\frac{196}{25}\pi$
	$[r=]\sqrt{\frac{196\pi}{25}\div\frac{160\pi}{360}}$ oe eg $[r=]\sqrt{\frac{196}{25}\times\frac{9}{4}}\left[=\frac{21}{5}=4.2\right]$			M1 implies previous M a correct calculation for the radius of the sector (slant height of cone)
	[radius of cone =] eg $\frac{196}{25}\div"4.2"\left[=\frac{28}{15}=1.866...\right]$ oe eg $\frac{\frac{160}{360}\times2\pi\times"4.2"[=11.7...]}{2\pi}\left[=\frac{28}{15}=1.866...\right]$			M1 for $\frac{196}{25}\div"r"$ where "*r*" is the candidate's value for the radius of the sector. If *r* is incorrect it must be clearly labelled and working for this method mark must be shown Condone radius of cone being labelled as *l*
	(cone height=) $\sqrt{"4.2"^2-"1.866..."^2}\left[=\frac{7\sqrt{65}}{15}=3.762...\right]$			M1 dep on first and third method marks, for a correct calculation for the height of the cone Follow through candidate's values for r or r and l. These must be clearly labelled and working shown if they are incorrect Condone $\sqrt{"1.866..."^2-"4.2"^2}$
	$\frac{1}{3}\times\pi\times"1.866..."^2\times"3.762..."[=4.36(99..)\pi]$			M1 dependent on previous four method marks for a correct calculation for the volume where *r* and *h* are from correct methods NB: $\frac{1}{3}\times\pi\times"4.2"^2\times"3.762..."$ does not get this mark
		13.7 (cm^3)		A1 13.4 to 13.9 SCB4 for 68.5 to 69.7
	cas			***Total 10 marks***

Question	Working	Answer	Mark	Notes
10 (a)		–2	1	B1 allow $x = -2$ or $x \neq -2$ **DO NOT** allow $x < -2$ or $x > -2$ or $y = -2$ or $y \neq -2$
(b)		15	1	B1 cao
(c)	$\frac{13}{x+2} = 5$ oe		2	M1 Setting g(x) = 5 Allow any letter for x
		0.6		A1 oe eg $\frac{3}{5}$
(d)	$[\text{fg}(x) =]\left(\frac{13}{x+2}\right)^2 + 2\left(\frac{13}{x+2}\right)$ oe or [g(24) =] $\frac{13}{24+2}$ [= 0.5] oe or f(0.5) oe		2	M1 For evidence of a correct first step eg finding fg(x) or sight of 0.5 (which may be embedded in their attempt at fg(24))
		1.25		A1 oe eg $\frac{5}{4}$
(e)	$\frac{13}{x^2+2x+2}[=4]$ or $\frac{13-2x}{x}\left[\Rightarrow \frac{13-2(4)}{4} = \frac{5}{4}\right]$ or $\frac{13}{x+2} = 4 \Rightarrow x = \frac{5}{4}$		4	M1 for a correct (un simplified) expression for gf(x) or for finding the inverse of g or for correctly solving g(x) = 4 may use a different letter to x eg $\frac{13}{t+2} = 4 \Rightarrow t = \frac{5}{4}$
	$4x^2 + 8x - 5[=0]$ oe eg $x^2 + 2x - \frac{5}{4}[=0]$ or $x^2 + 2x = \frac{5}{4}$			M1 a correct 3TQ
				M1 dependent on the first method mark For solving their 3 term quadratic using any correct method. Method may be implied by answers of 0.5 and –2.5 or by an answer of 0.5 Working must be shown if their quadratic is incorrect
		$\frac{1}{2}$		A1 dep on first method mark for just $\frac{1}{2}$ oe

(f)	$[y=]5(x^2-2x)-4$ or $[y=]5\left(x^2-2x-\frac{4}{5}\right)$		4	M1 for a correct start to write the quadratic in completed square form Allow x and y to be interchanged Condone division of all terms by 5 ie $x^2-2x-\frac{4}{5}$ oe
	$[y=]5\left((x-1)^2-1\right)-4$ or $[y=]5\left((x-1)^2-1-\frac{4}{5}\right)$			M1 implies previous method mark Allow $y=(\sqrt{5}x-\sqrt{5})^2-5-4$ oe Allow x and y to be interchanged Condone $(x-1)^2-1-\frac{4}{5}$ oe
	$\frac{y+9}{5}=(x-1)^2$			M1 Allow $y+9=\left(\sqrt{5}x-\sqrt{5}\right)^2$ oe Allow x and y to be interchanged
	Allow candidates to swap x and y when finding inverse	$[\mathrm{h}^{-1}: x\mapsto]$ $1+\sqrt{\frac{x+9}{5}}$		A1 oe eg $\frac{\sqrt{x+9}+\sqrt{5}}{\sqrt{5}}$ Must only have + and must be in x Do not ISW
(f) **alt**	$5x^2-10x-(y+4)[=0]$ oe		4	M1 for a correct first step of arranging all terms on the same side of an equation / expression
	$[x=]\frac{10\pm\sqrt{100-4\times5\times(-y-4)}}{10}$ oe			M1 dep for applying the quadratic formula correctly Allow with positive sign only eg $[x=]\frac{10+\sqrt{100-4\times5\times(-y-4)}}{10}$
	$[y=]\frac{10\pm\sqrt{180+20x}}{10}$ oe or $[x=]\frac{10+\sqrt{180+20y}}{10}$ oe			M1 dep on first M1 for recognising that x/y has to be positive in a correct expression or for having a correct expression in terms of x Allow un-simplified eg $[y=]\frac{10\pm\sqrt{100-4\times5\times(-x-4)}}{10}$
	Allow candidates to swap x and y when finding inverse	$[\mathrm{h}^{-1}: x\mapsto]$ $1+\sqrt{\frac{x+9}{5}}$		A1 oe eg $1+\frac{\sqrt{180+20x}}{10}$ Allow un-simplified eg $\frac{10+\sqrt{100-4\times5\times(-x-4)}}{10}$ or $\frac{10+\sqrt{180+20x}}{10}$ Must only have + and must be in x Do not ISW
	cas for parts (a), (b), (c), (d), (f) wr for part (e)			***Total 14 marks***

Question	Working	Answer	Mark	Notes
11	$2(5+y)^2+y^2+2y(5+y)=85$ or $2x^2+(x-5)^2+2x(x-5)=85$		6	M1 for substituting a linear equation into the quadratic equation Allow one sign error in their $(5+y)$ or $(x-5)$ This mark can be implied by an un simplified correct expansion in a correct equation eg $50+20y+2y^2+y^2+10y+2y^2=85$ or $2x^2+x^2-10x+25+2x^2-10x=85$
	$50+20y+2y^2+y^2+10y+2y^2=85$ or $2x^2+x^2-10x+25+2x^2-10x=85$			M1 for correct expansion of all brackets in a correct equation. Implied by a correct (simplified) quadratic expression. No simplification needed at this stage.
	$5y^2+30y-35[=0]$ oe eg $y^2+6y-7[=0]$ or $5x^2-20x-60[=0]$ oe eg $x^2-4x-12[=0]$			A1 dep on first method mark being awarded A correct 3 term quadratic in either x or y (oe so look for signs reversed, does not need to equal zero eg allow $x^2-4x=12$)
	eg $(5y-5)(y+7)[=0]$ oe or $\frac{-30\pm\sqrt{(30)^2-4\times5\times-35}}{2\times5}$ oe or $5(y+3)^2-80$ and $y=\pm\sqrt{\frac{80}{5}}-3$ oe eg $(x-6)(x+2)[=0]$ oe			M1 dependent on one of the two previous M marks. Solving their 3 term quadratic equation using any correct method. If the quadratic is correct then the method may be implied by 6 **and** –2 or by 1 **and** –7. Working must be shown if their quadratic is incorrect to gain this method mark. Condone incorrect labelling
	–2 and 6 or –7 and 1			A1 dep M3 and a correct quadratic For both x values correct or both y values correct Condone incorrect labelling
		Correct pairings $x=6, y=1$ $x=-2, y=-7$		A1 dep M3 and a correct quadratic For both pairs correct, must show **unambiguous** pairings. Allow as coordinates (6, 1) and (–2, –7) isw transcription errors eg exchanging x and y values. **Correct answer(s) with no working scores no marks**
	wr			***Total 6 marks***