Question			Answer	Marks	Guidance	
1			$[r=]\sqrt{\dfrac{A}{\pi(x+y)}}$ or $[r=]\sqrt{\dfrac{A}{\pi x+\pi y}}$ as final answer	2 **[2]**	square root symbol must extend below fraction line; accept to power ½ with appropriate brackets **M1** for a triple decker fraction or for $r^2=\dfrac{A}{\pi(x+y)}$ or for $[r=]\pm\sqrt{\dfrac{A}{\pi(x+y)}}$ or for their final answer for r ft their r^2	condone missing end bracket in denominator eg M1 for $[r=]\sqrt{\dfrac{A}{\dfrac{\pi}{(x+y)}}}$
2			$y = 4x + 10$	B3	**M1** for $y = 4x + b$ oe and **M1** for $y - 6 =$ their $a\ (x + 1)$ oe or for $(-1, 6)$ subst in $y =$ (their a)$x + b$ oe or **M1** for $y = ax + 10$	
			$(0, 10)$ or ft	B1	condone $y = 10$ isw	condone lack of brackets and eg $y = 10$, $x = -2.5$ or ft isw but B0, SC1 for poor notation such as $(-2.5, 10)$ with no better answers seen
			$(-10/4, 0)$ oe or ft	B1 **[5]**	condone $x = -10/4$ isw	Throughout the scheme, note that for evaluated rational answers, unless specified otherwise, fractional or decimal equivalents are acceptable, but not triple-decker fractions etc; integer answers must be simplified to an integer

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3	(i)		1	1 **[1]**		
3	(ii)		$\frac{3}{5}$ or 0.6	3 **[3]**	allow **B3** for ±0.6 oe; **M1** for $\left(\frac{25}{9}\right)^{-\frac{1}{2}} = \left(\frac{9}{25}\right)^{\frac{1}{2}}$ soi or $\frac{1}{\left(\frac{25}{9}\right)^{\frac{1}{2}}}$ and **M1** for at least one of 3 and 5 found	M1 for inversion even if they have done something else first, eg may be earned after 2nd M1 for inversion of their $\frac{5}{3}$
4			$4x - 5 > 14x + 7$	M1	for correctly multiplying by 7 to eliminate the fraction, including expanding bracket if this step done first	may be earned later; the first two Ms may be earned with an equation or wrong inequality
			$-12 > 10x$ or $-10x > 12$ or ft	M1	for correctly collecting x terms on one side and number terms on the other and simplifying	ft wrong first step
			$x < -\frac{12}{10}$ or $-\frac{12}{10} > x$ oe isw or ft	M1 **[3]**	ft their ax [inequality] b, where $b \neq 0$ and $a \neq 0$ or ±1	award 3 marks only if correct answer obtained after equations or inequalities are used with no errors
5			$x + 3(5x - 2) = 8$ or $y = 5(8 - 3y) - 2$	M1	for subst to eliminate one variable; condone one error;	or multn or divn of one or both eqns to get a pair of coeffts the same, condoning one error
			$16x = 14$ or $16y = 38$	M1	for collecting terms and simplifying; condoning one error ft	appropriate addn or subtn to eliminate a variable, condoning an error in one term; if subtracting, condone eg y instead of 0 if no other errors
			(7/8, 19/8) oe	A2 **[4]**	or $x = 14/16$, $y = 38/16$ oe isw allow **A1** for each coordinate	

Question			Answer	Marks	Guidance	Question
6	(i)		$-31 + 6\sqrt{5}$	3 **[3]**	**B2** for -31 or **B1** for $9 - 40$ or **SC1** for 49 <u>and</u> **B1** for $6\sqrt{5}$ if 0, allow **M1** for three terms correct in $9-6\sqrt{5}+12\sqrt{5}-40$	
6	(ii)		$22\sqrt{2}$	2 **[2]**	**M1** for $\sqrt{72}=6\sqrt{2}$ soi or for $\frac{32}{\sqrt{2}}=16\sqrt{2}$ soi or for $\frac{12+32}{\sqrt{2}}$ oe	
7			$81x^4 - 216x^3 + 216x^2 - 96x + 16$	4 **[4]**	**M3** for 4 terms correct or for all coefficients correct except for sign errors or for correct answer seen then further 'simplified' or for all terms correct eg seen in table but not combined or **M2** for 3 terms correct or for correct expansion seen without correct evaluation of coefficients [if brackets missing in elements such as $(3x)^2$ there must be evidence from calculation that $9x^2$ has been used] or **M1** for 1 4 6 4 1 row of Pascal's triangle seen	condone eg $+(-96x)$ or $+-96x$ instead of $-96x$ any who multiply out instead of using binomial coeffts: look at their final answer and mark as per main scheme if 3 or more terms are correct, otherwise M0 binomial coefficients such as ${}^4C_2$ or $\binom{4}{2}$ are not sufficient – must show understanding of these symbols by at least partial evaluation;

Question			Answer	Marks	Guidance	Question
8	(i)		$(3x)^2 = h^2 + (2x+1)^2$ oe	B1	for a correct Pythagoras statement for this triangle, in terms of x, with correct brackets	condone another letter instead of h for one mark but not both unless recovered at some point
			$9x^2 = h^2 + 4x^2 + 4x + 1$ and completion to given answer , $h^2 = 5x^2 - 4x - 1$	B1	for correct expansion, with brackets or correct signs; must complete to the given answer with no errors in any interim working may follow $3x^2 = h^2 + (2x+1)^2$ oe for **B0 B1**	eg B1 for $h^2 = 9x^2 - (4x^2 + 4x + 1)$ and completion to correct answer but B0 for $h^2 = 9x^2 - 4x^2 + 4x + 1$
				[2]		
8	(ii)		[0 =] $5x^2 - 4x - 8$	B1	for subst and correctly rearranging to zero	
			$\dfrac{4 \pm \sqrt{(-4)^2 - 4 \times 5 \times -8}}{2 \times 5}$ or ft	M1	for use of formula in their eqn rearranged to zero, condoning one error; ft only if their rearranged eqn is a 3-term quadratic; no ft from $5x^2 - 4x - 1$ [=0]	or M1 for $\left(x - \dfrac{2}{5}\right)^2 = \left(\dfrac{2}{5}\right)^2 + \dfrac{8}{5}$ oe, (condoning one error), which also implies first M1 if not previously earned M0 for factorising ft
			$\dfrac{4 + \sqrt{176}}{10}$ or $\dfrac{2}{5} + \dfrac{\sqrt{44}}{5}$ oe	A1	isw wrong simplification; **A0** if negative root also included	
				[3]		
9	(i)		the diagonals of a rhombus also intersect at 90°	B1	oe for kite or other valid statement/sketch **B0** if eg rectangle or parallelogram etc also included as having diagonals intersecting at 90°	accept 'diamond' etc reference merely to 'other shapes' having diagonals intersecting at 90° is not sufficient; sketches must have diagonals drawn, intersecting approx. at right angles but need not be ruled
			ABCD is a square $\Rightarrow$ the diagonals of quadrilateral ABCD intersect at 90°	B1	oe; **B0** if no attempt at explanation (explanation does not need to gain a mark)	Do not accept $\rightarrow$ oe
				[2]		

Question			Answer	Marks	Guidance	Question
9	(ii)		eg 8 is an integer but $\sqrt{8}$ is not an integer	B1	oe with another valid number, or equivalent explanation **B1** for the square root of some integers is a surd / irrational number / decimal	 0 for 'the square root of some integers is a fraction'
			x^2 is an integer $\Leftarrow x$ is an integer	B1 **[2]**	**B0** if no attempt at explanation	Do not accept $\leftarrow$ oe
10	(i)		graph of cubic correct way up	B1	**B0** if stops at x-axis	must not have any ruled sections; no curving back; condone slight 'flicking out' at ends but not approaching a turning point; allow max on y-axis or in 1st or 2nd quadrants; condone some 'doubling' or 'feathering' (deleted work still may show in scans)
			crossing x-axis at –3, 2 and 5	B1	on graph or nearby; may be in coordinate form mark intent for intersections with both axes	allow if no graph, but marked on x-axis condone intercepts for x and / or y given as reversed coordinates
			crossing y-axis at 30	B1 **[3]**	or $x = 0$, $y = 30$ seen if consistent with graph drawn	allow if no graph, but eg B0 for graph with intn on y-axis nowhere near their indicated 30
10	(ii)		correct expansion of two of the linear factors	M1	may be 3 or 4 terms	condone lack of brackets if correct expansions as if they were there
			correct expansion and completion to given answer, $x^3 - 4x^2 - 11x + 30$	A1 **[2]**	must be working for this step before given answer	or for direct expansion of all three factors, allow M1 for $x^3 + 3x^2 - 2x^2 - 5x^2 - 6x - 15x + 10x + 30$, condoning an error in one term , and A1 if no error for completion by stating given answer

Question			Answer	Marks	Guidance	Question
10	(iii)		translation	B1	0 for shift or move etc without stating translation	0 if eg stretch also mentioned
			$\begin{pmatrix} 0 \\ -36 \end{pmatrix}$	B1	or 36 down, or –36 in *y* direction oe	if conflict, eg between '–36 in *y* direction' and wrong vector, award B0
						0 for '–36 down'
				[2]		
10	(iv)		$-1 - 4 + 11 - 6 = 0$	B1	or **B1** for correct division by $(x + 1)$ or for the quadratic factor found by inspection, <u>and</u> the conclusion that no remainder means that $g(-1) = 0$	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient
			attempt at division by $(x + 1)$ as far as $x^3 + x^2$ in working	M1	or inspection with at least two terms of three–term quadratic factor correct; or finding $f(6) = 0$	M0 for trials of factors to give cubic unless correct answer found with clear correct working, in which case award the M1A1M1A1
			correctly obtaining $x^2 -5x - 6$	A1	or $(x - 6)$ found as factor	
			factorising the correct quadratic factor $x^2 -5x - 6$, that has been correctly obtained	M1	for factors giving two terms of quadratic correct or for factors ft one error in quadratic formula or completing square; **M0** for formula etc without factors found for those who have used the factor theorem to find $(x - 6)$, **M1** for working with cubic to find that $(x + 1)$ is repeated	allow for $(x - 6)$ and $(x +1)$ given as factors eg after quadratic formula etc
			$(x - 6)(x +1)^2$ oe isw	A1	condone inclusion of '= 0'	isw roots found, even if stated as factors just the answer $(x - 6)(x +1)^2$ oe gets last 4 marks
				[5]		

Question			Answer	Marks	Guidance	Question
11	**(i)**		[radius =] $\sqrt{125}$ isw or $5\sqrt{5}$	B1		
			[C =] (10, 2)	B1	condone $x = 10$, $y = 2$	
				[2]		
11	**(ii)**		verifying / deriving that (21, 0) is one of the intersections with the axes	B1	using circle equation or Pythagoras; or putting $y = 0$ in circle equation and solving to get 21 and −1; condone omission of brackets	equation may be expanded first
			(–1, 0)	B1		condone not written as coordinates
			(0, –3) and (0, 7)	B2	**B1** each;	condone not written as coordinates; condone not identified as D and E; condone D = (0, 7), E = (0, –3) – will penalise themselves in (iii)
					if B0 for D and E, then **M1** for substitution of $x = 0$ into circle equation or use of Pythagoras showing $125 - 10^2$ or $h^2 + 10^2 = 125$ ft their centre and/or radius	
				[4]		

Question			Answer	Marks	Guidance	Question
11	(iii)		midpt BE = (21/2 , 7/2 ft) oe	B1	ft their E or stating that the perp bisector of a chord always passes through the centre of the circle	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient must be explicit generalised statement; need more than just that C is on this perp bisector
			grad BE = $\frac{7-0}{0-21}$ oe isw	M1	ft their E; M0 for using grad BC (= –2/11)	condone –1/3x oe
			grad perp bisector = 3 oe	M1	for use of $m_1m_2 = -1$ oe soi; ft their grad BE; no ft from grad BC used	condone 3x oe; allow M1 for eg –1/3 × 3 = –1
			y – 7/2 = 3(x – 21/2) oe	M1	ft; M0 for using grad BE or perp to BC allow this M1 for C used instead of midpoint	or use of $y = 3x + c$ and subst of (21/2 , 7/2) oe ft
			$y = 3x - 28$ oe	A1	must be a simplified equation	no ft; those who assume that C is on the line and use it to find $y = 3x - 28$ can earn B0M1M1M1A1A0 those who argue that the perp bisector of a chord always passes through the centre of the circle and then uses C rather than midpt of BE are eligible for all 6 marks
			verifying that (10, 2) is on this line	A1 **[6]**	no ft; A0 if C used to find equation of line, unless B1 earned for correct argument	

Question			Answer	Marks	Guidance	Question
12	(i)		$3x^2 + 12x + 13 = 2x + k$	M1	oe eg M1 for $3x^2 + 10x + 13 = k$	condone $3x^2 + 10x + 13 - k = y$ for this M1
			$3x^2 + 10x + 13 - k$ [= 0]	M1	for rearranging to 0; condone one error in adding/subtracting; but M0 for $3x^2 + 10x + 13 = k$ or $3x^2 + 10x + 13 - k = y$	$3x^2 + 10x + 13 - k$ [= 0] will also earn the first M1 if a separate statement has not already done so
			$b^2 - 4ac > 0$ oe soi	M1	may be earned near end with correct inequality sign used there	allow '$b^2 - 4ac$ is positive' oe; 0 for just 'discriminant > 0' unless implied by later work
			$100 - 4 \times 3 \times (13 - k)$ (> 0) oe	M1	for correct substitution ft into $b^2 - 4ac$, dep on second M1 earned; brackets / signs must be correct	can be earned with equality or wrong inequality, or in formula M0 for trials of values of k in $b^2 - 4ac$
			$k > 14/3$ oe	A1 **[5]**	accept $k > 56/12$ or better, isw incorrect conversion of fraction but not wrong use of inequalities if A0, allow **B1** for 56/12 oe obtained with equality or wrong inequality (ie 3rd M1 has not been earned)	

Question			Answer	Marks	Guidance	Question
12	(ii)		$3(x+2)^2+1$ www as final answer	B4	**B1** for $a = 3$ and **B1** for $b = 2$ and **B2** for $c = 1$ or **M1** for $13 - 3 \times$ their b^2 or for $13/3 -$ their b^2 or **B3** for $3\left[(x+2)^2+\frac{1}{3}\right]$	condone omission of square symbol; ignore equating to zero in working or answer
			y-minimum = 1 [hence curve is above x-axis]	B1 **[5]**	Stating min pt is (–2, 1) is sufft allow ft if their $c > 0$ B0 for only showing that discriminant is negative oe; need also to justify that it is all above not all below x-axis B0 for stating min point = 1 or ft	must be done in this part; ignore wrong x-coordinate
12	(iii)		5 cao	B2 **[2]**	**M1** for substitution of their (–2, 1) in $y = 2x + k$	allow M1 ft their $3(x+2)^2+1$; or use of (–2,1) found using calculus; M0 if they use an incorrect minimum point inconsistent with their completed square form