Question			Answer	Marks	Guidance	
1	(i)		$\frac{1}{9}$	2 **[2]**	isw conversion to decimal M1 for 9 or for 3^{-2} or for $\frac{1}{3}$ Except M0 for 9 from 27/3 or $\sqrt[3]{27}$	ie M1 for evidence of $(\sqrt[3]{27})^2$ or $1/(\sqrt[3]{27})$ found correctly
1	(ii)		$2a^2c^{-4}$ or $\frac{2a^2}{c^4}$ as final answer	3 **[3]**	B1 for each element; must be multiplied if B0, allow SC1 for $64a^6c^3$ obtained from numerator or for all elements correct but added	
2			midpt M of AB = $\left(\frac{1+6}{2}, \frac{5-1}{2}\right)$ oe isw soi subst of their midpt into $y = 2x - 5$ and attempting to evaluate all work correct and 'Yes' oe	M1 M1 A1 **[3]**	condone lack of brackets; accept in the form $x = 7/2$ oe, $y = 2$ oe eg 2 × their 3.5 – 5 = their result accept 2 = 2 × 3.5 – 5	<u>alt methods</u>: allow 2nd M1 for finding correct eqn of AB as $y = -\frac{6x}{5} + \frac{31}{5}$ oe <u>and</u> attempting to solve as simult eqn with $y = 2x - 5$ for x or y or allow M1 for finding in unsimplified form the eqn of the line through their midpt with gradient 2 and A1 for showing it is $y = 2x - 5$, so Yes

Question			Answer	Marks	Guidance	
3	(i)		graph of shape with vertices at (–2, –3), (0, 0) and (2, –4)	2 **[2]**	M1 for 2 vertices correct	condone lines unruled; condone just missing vertex: ¼ grid square tolerance
3	(ii)		graph of shape with vertices at (1, –1), (3, 2) and (5, –2)	2 **[2]**	M1 for 2 vertices correct or for shape with vertices at (–5, –1), (–3, 2) and (–1, –2)	condone lines unruled; condone just missing vertex: ¼ grid square tolerance
4	(i)		$61-28\sqrt{3}$	3 **[3]**	B2 for 61 or B1 for 49 + 12 found in expansion (may be in a grid) and B1 for $-28\sqrt{3}$ if B0, allow M1 for at least three terms correct in $49-14\sqrt{3}-14\sqrt{3}+12$ the correct answer obtained then spoilt earns SC2 only	
4	(ii)		$4\sqrt{3}$	2 **[2]**	M1 for $\sqrt{50}=5\sqrt{2}$ or $\sqrt{300}=10\sqrt{3}$ or $20\sqrt{300}=200\sqrt{3}$ or $\sqrt{48}=2\sqrt{12}$ seen	

Question			Answer	Marks	Guidance	
5			$3a + 12$ [$= ac + 5f$]	M1	for expanding brackets correctly	annotate this question if partially correct
			$3a - ac = 5f - 12$ or ft	M1	for collecting a terms on one side, remaining terms on other	ft only if two a terms
			$a(3 - c) = 5f - 12$ or ft	M1	for factorising a terms; may be implied by final answer	ft only if two a terms, needing factorising may be earned before 2nd M1
			$[a =]\dfrac{5f - 12}{3 - c}$ oe or ft as final answer	M1	for division by their two-term factor; for all 4 marks to be earned, work must be fully correct	
				[4]		
6			$(3x + 1)(x + 3)$	M1	or $3(x + 1/3)(x + 3)$ or for $-1/3$ and -3 found as endpoints eg by use of formula	
			$x < -3$ [or]	A1		
			$x > -1/3$ oe	A1	mark final answers;	
					allow only A1 for $-3 > x > -1/3$ oe as final answer or for $x \le -3$ and $x \ge -1/3$	A0 for combinations with only one part correct eg $-3 > x < -1/3$, though this would earn M1 if not already awarded
					if M0, allow SC1 for sketch of parabola the right way up with their solns ft their endpoints	
				[3]		

Question			Answer	Marks	Guidance	
7			70 000 www	4	throughout, condone xs included eg $(2x)^4$	annotate this question if partially correct
						allow 4 for 70 000x^4 www;
						may also include other terms in expansion. Allow marks even if wrong term selected; mark the coefficient of x^4
					M3 for $35 \times 5^3 \times 2^4$ oe	may be unsimplified, but do not allow 35 in factorial form unless evaluated later
					or M2 for two of these elements multiplied	or for all three elements seen together (eg in table) but not multiplied
					or M1 for 35 oe or for 1 7 21 35 35 21 7 1 row of Pascal's triangle seen	
				[4]		

Question			Answer	Marks	Guidance	
8			use of $f(2)$	M1	2 substituted in $f(x)$ or $f(2) = 42$ seen or correct division of $4x^3 + kx + 6$ by $x - 2$ as far as obtaining $4x^2 + 8x + (k + 16)$ oe [may have $4x^2 + 8x + 18$]	
			$4 \times 2^3 + 2k + 6 = 42$	M1	or $6 + 2(k + 16) = 42$ oe or finding (usually after division) that the constant term is 36 and then working with the x term to find k eg $kx + 16x = 18x$	
			$k = 2$	A1		
			[x =] -1	A1	as their answer, not just a trial; A0 for just $f(-1) = 0$ with no further statement A0 if confusion between roots and factors in final statement eg '$x + 1$ is a root', even if they also state $x = -1$	accept with no working since it can be found by inspection
				[4]		

Question			Answer	Marks	Guidance	
9	(i)		$3n^2 + 6n + 5$ isw	B2 **[2]**	M1 for a correct expansion of at least one of $(n + 1)^2$ and $(n + 2)^2$	
9	(ii)		odd numbers with valid explanation	B2 **[2]**	marks dep on 9(i) correct or starting again for B2 must see at least odd × odd = odd [for $3n^2$] (or when n is odd, [3]n^2 is odd) and odd [+ even] + odd = even soi, condone lack of odd × even = even for $6n$; condone no consideration of n being even or B2 for deductive argument such as: $6n$ is always even [and 5 is odd] so $3n^2$ must be odd so n is odd B1 for odd numbers with a correct partial explanation or a partially correct explanation or B1 for an otherwise fully correct argument for odd numbers but with conclusion positive odd numbers or conclusion negative odd numbers B0 for just a few trials and conclusion	accept a full valid argument using odd and even from starting again Ignore numerical trials or examples in this part – only a generalised argument can gain credit

Question			Answer	Marks	Guidance	
10	**(i)**		(7, 0)	1 **[1]**	accept $x = 7$, $y = 0$	condone 7, 0
10	**(ii)**		$\sqrt{13}$ $(x-4)^2 + (y-2)^2 = 13$ or ft their evaluated r^2, isw	2 2 **[4]**	M1 for Pythagoras used correctly eg $[r^2 =]\ 3^2 + 2^2$ or for subst A or their B in $(x-4)^2+(y-2)^2\left[=r^2\right]$ or B1 for $[r =]\ \pm\sqrt{13}$ M1 for one side correct, as part of an equation with x and y terms	annotate this question if partially correct allow recovery if some confusion between squares and roots but correct answer found do not accept $(\sqrt{13})^2$ instead of 13; allow M1 for LHS for $(x-4)^2+(y-2)^2=r^2$ (or worse, $(x-4)^2+(y-2)^2=r$) (may be seen in attempt to find radius)
10	**(iii)**		(7, 4)	2 **[2]**	B1 each coord accept $x = 7$, $y = 4$ if B0, then M1 for a vector or coordinates approach such as '3 along and 2 up' to get from A to C oe or M1 for $\frac{x_D+1}{2}=4$ and $\frac{y_D+0}{2}=2$	condone 7, 4 or M1 for longer method, finding the equation of the line CD as $y = 2/3\ (x-1)$ oe <u>and</u> then attempting to find intn with their circle

Question			Answer	Marks	Guidance	
10	(iv)		grad tgt = –3/2 oe	M2	correctly obtained or ft their D if used M1 for grad AD = $\frac{4-0}{7-1}$ oe isw or 2/3 oe seen or used in this part or for their grad tgt = –1/ their grad AD	annotate this question if partially correct may use AD, CD or AC NB grad AD etc may have been found in part (iii); allow marks if used in this part – mark the copy of part (iii) that appears below the image for part (iv)
			y – their 4 = their (–3/2) (x – their 7)	M1	or subst (7, 4) into y = their (–3/2) $x + b$ M0 if grad AD oe used or if a wrong gradient appears with no previous working	
			$y = -1.5x + 14.5$ oe isw	A1	must be in form $y = ax + b$	condone $y = \frac{-3x+29}{2}$ condone $y = -1.5x + b$ and $b = 14.5$ oe
				[4]		

Question			Answer	Marks	Guidance	
11	(i)		$x = 4$	B1		
			$(4, -3)$	B1	or $x = 4$, $y = -3$	condone $4, -3$
				[2]		
11	(ii)		$(0, 13)$ isw	1	or [when $x = 0$], $y = 13$ isw 0 for just $(13, 0)$ or $(k, 13)$ where $k \neq 0$	annotate this question if partially correct
			[when $y = 0$,] $(x - 4)^2 = 3$	M1	or $x^2 - 8x + 13$ [= 0]	may be implied by correct value(s) for x found allow M1 for $y = x^2 - 8x + 13$ only if they go on to find values for x as if y were 0
			$[x =]4 \pm \sqrt{3}$ or $\dfrac{8 \pm \sqrt{12}}{2}$ isw	A2	need not go on to give coordinate form A1 for one root correct	
				[4]		
11	(iii)		replacement of x in their eqn by $(x - 2)$	M1	may be simplified; eg [$y =$] $(x - 6)^2 - 3$ or allow M1 for $(x - 6 - \sqrt{3})(x - 6 + \sqrt{3})$ [=0 or y]	condone omission of '$y =$' for M1, but must be present in final line for A1
			completion to given answer $y = x^2 - 12x + 33$, showing at least one correct interim step	A1	cao; condone using $f(x - 2)$ in place of y	
				[2]		

Question			Answer	Marks	Guidance	
11	(iv)		$x^2 - 12x + 33 = 8 - 2x$ or $(x - 6)^2 - 3 = 8 - 2x$	M1	for equating curve and line; correct eqns only; or for attempt to subst $(8 - y)/2$ for x in $y = x^2 - 12x + 33$	annotate this question if partially correct
			$x^2 - 10x + 25 = 0$	M1	for rearrangement to zero, condoning one error such as omission of '= 0'	
			$(x - 5)^2$ [= 0]	A1	or showing $b^2 = 4ac$	allow $\frac{10 \pm \sqrt{0}}{2}$ oe if $b^2 - 4ac = 0$ is not used explicitly A0 for $(x - 5)^2 = y$
			$x = 5$ www [so just one point of contact]	A1	may be part of coordinates $(5, k)$	allow recovery from $(x - 5)^2 = y$
			point of contact at $(5, -2)$	A1	dependent on previous A1 earned; allow for $y = -2$ found	
			<u>alt. method</u>	**or**		examiners: use one mark scheme or the other, to the benefit of the candidate if both methods attempted, but do not use a mixture of the schemes
			for curve, $y' = 2x - 12$	M1		
			$2x - 12 = -2$	M1	for equating their y' to -2	
			$x = 5$, and y shown to be -2 using eqn to curve	A1		
			tgt is $y + 2 = -2(x - 5)$	A1		
			deriving $y = 8 - 2x$	A1		condone no further interim step if all working in this part is correct so far
				[5]		

Question			Answer	Marks	Guidance	
12	(i)		$y = (x+5)(x+2)(2x-3)$ or $y = 2(x+5)(x+2)(x-3/2)$	2 **[2]**	M1 for $y = (x+5)(x+2)(x-3/2)$ or $(x+5)(x+2)(2x-3)$ with no equation or $(x+5)(x+2)(2x-3) = 0$ but M0 for $y = (x+5)(x+2)(2x-3) - 30$ or $(x+5)(x+2)(2x-3) = 30$ etc	allow 'f(x) =' instead of 'y = ' ignore further work towards (ii) but do not award marks for (i) in (ii)
12	(ii)		correct expansion of a pair of their linear two-term factors ft isw correct expansion of the correct linear and quadratic factors and completion to given answer $y = 2x^3 + 11x^2 - x - 30$	M1 M1 **[2]**	ft their factors from (i); need not be simplified; may be seen in a grid must be working for this step before given answer or for direct expansion of all three factors, allow M2 for $2x^3 + 10x^2 + 4x^2 - 3x^2 + 20x - 15x - 6x - 30$ oe (M1 if one error) or M1M0 for a correct direct expansion of $(x+5)(x+2)(x-3/2)$ condone lack of brackets if used as if they were there	allow only first M1 for expansion if their (i) has an extra -30 etc do not award 2nd mark if only had $(x-3/2)$ in (i) and suddenly doubles RHS at this stage condone omission of 'y =' or inclusion of '= 0' for this second mark (some cands have already lost a mark for that in (i)) allow marks if this work has been done in part (i) – mark the copy of part (i) that appears below the image for part (ii)

Question			Answer	Marks	Guidance	
12	(iii)		ruled line drawn through (–2, 0) and (0, 10) and long enough to intersect curve at least twice	B1	tolerance half a small square on grid at (–2, 0) and (0, 10)	insert BP on spare copy of graph if not used, to indicate seen – this is included as part of image, so scroll down to see it
			–5.3 to –5.4 and 1.8 to 1.9	B2	B1 for one correct ignore the solution –2 but allow B1 for both values correct but one extra or for wrong 'coordinate' form such as (1.8, –5.3)	accept in coordinate form ignoring any y coordinates given;
				[3]		
12	(iv)		$2x^3 + 11x^2 - x - 30 = 5x + 10$	M1	for equating curve and line; correct eqns only	annotate this question if partially correct
			$2x^3 + 11x^2 - 6x - 40$ [= 0]	M1	for rearrangement to zero, condoning one error	
			division by $(x + 2)$ and correctly obtaining $2x^2 + 7x - 20$	M1	or showing that $(x + 2)(2x^2 + 7x - 20) = 2x^3 + 11x^2 - 6x - 40$, with supporting working	
			substitution into quadratic formula or for completing the square used as far as $\left(x+\frac{7}{4}\right)^2 = \frac{209}{16}$ oe	M1	condone one error eg a used as 1 not 2, or one error in the formula, using given $2x^2 + 7x - 20 = 0$	
			$[x =]\dfrac{-7 \pm \sqrt{209}}{4}$ oe isw	A1	dependent only on 4th M1	
				[5]		