1	neg quadratic curve intercept (0, 9) <u>through</u> (3, 0) and (−3, 0)	1 1 1	condone (0, 9) seen eg in table	3

2	**I**	$x-2$ is factor soi attempt at divn by $x-2$ as far as x^3-2x^2 seen in working x^2+2x-1 obtained attempt at quad formula or comp square $-1\pm\sqrt{2}$ as final answer	M1 M1 A1 M1 A2	eg may be implied by divn or other factor (x^2 ….−1) or (x^2+2x...) or B3 www ft their quadratic A1 for $\dfrac{-2\pm\sqrt{8}}{2}$ seen; or B3 www	6
	ii	$f(x-3)=(x-3)^3-5(x-3)+2$ $(x-3)(x^2-6x+9)$ or other constructive attempt at expanding $(x-3)^3$ eg 1 3 3 1 soi $x^3-9x^2+27x-27$ $-5x+15$ [+2]	B1 M1 A1 B1	or $(x-5)(x-2+\sqrt{2})(x-2-\sqrt{2})$ soi or ft from their (i) for attempt at multiplying out 2 brackets or valid attempt at multiplying all 3 alt: A2 for correct full unsimplified expansion or A1 for correct 2 bracket expansion eg $(x-5)(x^2-4x+2)$	4
	iii	5 $2\pm\sqrt{2}$ or ft	B1 B1	condone factors here, not roots if B0 in this part, allow SC1 for their roots in (i) − 3	2

3		f(–2) used –8 + 36 – 40 + 12 = 0	M1 A1	or M1 for division by (x + 2) attempted as far as $x^3 + 2x^2$ then A1 for $x^2 + 7x + 6$ with no remainder	2
	ii	divn attempted as far as $x^2 + 3x$ $x^2 + 3x + 2$ or $(x + 2)(x + 1)$	M1 A1	or inspection with b = 3 or c = 2 found; B2 for correct answer	2
	iii	$(x + 2)(x + 6)(x + 1)$	2	allow seen earlier; M1 for $(x + 2)(x + 1)$	2
	iv	sketch of cubic the right way up <u>through</u> 12 marked on y axis intercepts –6, –2, –1 on x axis	G1 G1 G1	with 2 turning pts; no 3rd tp curve must extend to $x > 0$ condone no graph for $x < -6$	3
	v	$[x](x^2 + 9x + 20)$ $[x](x + 4)(x + 5)$ x = 0, –4, –5	M1 M1 A1	or other partial factorisation or B1 for each root found e.g. using factor theorem	3

4		sketch of cubic the correct way up curve passing through (0, 0) curve touching x axis at (3, 0)	G1 G1 G1		3
	ii	$x(x^2 - 6x + 9) = 2$ $x^3 - 6x^2 + 9x = 2$	M1 M1	or $(x^2 - 3x)(x - 3) = 2$ [for one step in expanding brackets] for 2nd step, dep on first M1	2
	iii	subst x = 2 in LHS of their eqn or in $x(x - 3)^2 = 2$ o.e. working to show consistent division of their eqn by $(x - 2)$ attempted $x^2 - 4x + 1$	1 1 M1 A1	or 2 for division of their eqn by $(x - 2)$ and showing no remainder or inspection attempted with $(x^2 + kx + c)$ seen	

		soln of their quadratic by formula or completing square attempted $x = 2 \pm \sqrt{3}$ or $(4 \pm \sqrt{12})/2$ isw locating the roots on intersection of their curve and $y = 2$	M1 A2 G1	condone ignoring remainder if they have gone wrong A1 for one correct must be 3 intns; condone $x = 2$ not marked; mark this when marking sketch graph in (i)	7 G1

5	i	grad AB $= \frac{9-1}{3--1}$ or 2 $y - 9 = 2(x - 3)$ or $y - 1 = 2(x + 1)$ $y = 2x + 3$ o.e.	M1 M1 A1	ft their *m*, or subst coords of A or B in y = their $m\,x + c$ or B3	3
	ii	mid pt of AB = (1, 5) grad perp = −1/grad AB $y - 5 = -\frac{1}{2}(x - 1)$ o.e. or ft [no ft for just grad AB used] at least one correct interim step towards given answer $2y + x = 11$, and correct completion NB ans $2y + x = 11$ given	M1 M1 M1 M1	condone not stated explicitly, but used in eqn soi by use eg in eqn ft their grad and/or midpt, but M0 if their midpt not used; allow M1 for $y = -\frac{1}{2}x + c$ and then their midpt subst no ft; correct eqn only	

		<u>alt method working back from ans:</u>		mark one method or the other, to benefit of cand, not a mixture		
		$y=\frac{11-x}{2}$ o.e.	M1			
		grad perp = −1/grad AB and showing/stating same as given line	M1	eg stating $-\frac{1}{2}\times 2=-1$		
		finding intn of their $y=2x+3$ and $2y+x=11$ [= (1, 5)]	M1	or showing that (1, 5) is on $2y+x$ = 11, having found (1, 5) first	4	
		showing midpt of AB is (1, 5)	M1	[for both methods: for M4 must be fully correct]		
	iii	showing $(-1-5)^2+(1-3)^2=40$	M1	at least one interim step needed for each mark; M0 for just $6^2+2^2=40$ with no other evidence such as a first line of working or a diagram;		
		showing B to centre = $\sqrt{40}$ or verifying that (3, 9) fits given circle	M1	condone marks earned in reverse order	2	
	iv	$(x-5)^2+3^2=40$	M1	for subst $y=0$ in circle eqn		
		$(x-5)^2=31$	M1	condone slip on rhs; or for rearrangement to zero (condone one error) <u>and</u> attempt at quad. formula [allow M1 M0 for $(x-5)^2=40$ or for $(x-5)^2+3^2=0$]		
		$x=5\pm\sqrt{31}$ or $\frac{10\pm\sqrt{124}}{2}$ isw	A1	or $5\pm\frac{\sqrt{124}}{2}$	3	12