1			$5(x + 1.5)^2 + 0.75$ oe www	4	B1 for $a = 5$ and B1 for $b = 3/2$ oe and B2 for $c = 3/4$ oe or M1 for $12 - 5 \times (\text{their } 3/2)^2$ oe soi or for $2.4 - (\text{their } 3/2)^2$ oe [eg 0.15] soi	condone omission of square symbol eg $5[(x + 7.5)^2 - 7.5^2] + 12$ oe earns B1B0M1ft
			0.75 oe or ft their c	1 **[5]**	0 for (−1.5, 0.75)	condone found independently eg by differentiation

Question			Answer	Marks	Guidance	
2	(i)		f(–3) used	M1		
			$-54 - 27 + 69 + 12$ [= 0] isw	A1	or M1 for correct division by $(x + 3)$ or for the quadratic factor found by inspection and A1 for concluding that $x = -3$ [is a root] (may be earned later)	A0 for concluding that $x = -3$ is a factor
			attempt at division by $(x + 3)$ as far as $2x^3 + 6x^2$ in working	M1	or inspection with at least two terms of three–term quadratic factor correct; or at least one further root found using remainder theorem	
			correctly obtaining $2x^2 - 9x + 4$	A1	or stating further factor, found from using remainder theorem again	
			factorising the correct quadratic factor	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	allow for $(x - 4)$ and $(x - ½)$ given as factors eg after using remainder theorem again or quadratic formula etc
			$(2x - 1)(x - 4)[(x + 3)]$ isw	A1	allow $2(x - ½)$ instead of $(2x - 1)$, oe condone inclusion of '= 0'	isw $(x - ½)$ as factor and/or roots found, even if stated as factors
				[6]		

Question			Answer	Marks	Guidance	
2	(ii)		sketch of cubic right way up, with two turning points	B1	0 if stops at x-axis ignore graph of $y = 4x + 12$	must not be ruled; no curving back (except condone between $x = 0$ and $x = 0.5$); condone some 'flicking out' at ends but not approaching more turning points; must continue beyond axes; allow max on y axis or in 1st or 2nd quadrants condone some doubling / feathering
			values of intns on x axis shown, correct (–3, 0.5 and 4) or ft from their factors or roots in (i)	B1	on graph or nearby in this part mark intent for intersections with both axes	allow if no graph condone 3 on neg x axis as slip for –3; condone eg 0.5 roughly halfway between their 0 and 1 marked on x axis
			12 marked on y-axis	B1 **[3]**	or $x = 0$, $y = 12$ seen in this part if consistent with graph drawn	allow if no graph, but eg B0 for graph with intn on –ve y-axis or nowhere near their indicated 12
2	(iii)		$2x^3 - 3x^2 - 23x + 12 = 4x + 12$ oe	M1	or ft their factorised f(x)	
			$2x^3 - 3x^2 - 27x$ [= 0]	A1	after equating, allow A1 for cancelling (x + 3) factor on both sides and obtaining $2x^2 - 9x$ [= 0]	condone slip of '= y' instead of '= 0'
			[x]$(2x - 9)(x + 3)$ [= 0]	M1	for linear factors of correct cubic, giving two terms correct or for quadratic formula or completing square used on correct quadratic $2x^2 - 3x - 27 = 0$, condoning one error in formula etc;	or after cancelling (x + 3) factor allow M1 for $x(2x - 9)$ oe or obtaining $x = 0$ or 9/2 oe M0 for eg quadratic formula used on cubic, unless recovery and all 3 roots given
			[x =] 0, –3 and 9/2 oe	A1 **[4]**	need not be all stated together	eg $x = 0$ may be earlier

3	(i) $y = 2x + 5$ drawn -2, -1.4 to -1.2, 0.7 to 0.85	**M1** **A2**	 **A1** for two of these correct	condone unruled and some doubling; tolerance: must pass within/touch at least two circles on overlay; the line must be drawn long enough to intersect curve at least twice; condone coordinates or factors
3	(ii) $4x^3 + 5x^2$ or $2x+5-\frac{4}{x^2}=0$ and completion to given answer	**B1**		condone omission of final '= 0';
	$f(-2) = -16 + 20 - 4 = 0$	**B1**	or correct division / inspection showing that $x + 2$ is factor;	
	use of $x + 2$ as factor in long division of given cubic as far as $2x^3 + 4x^2$ in working	**M1**	or inspection or equating coefficients, with at least two terms correct;	may be set out in grid format
	$2x^2 + x - 2$ obtained	**A1**		condone omission of + sign (eg in grid format)
	$[x=]\frac{-1\pm\sqrt{1^2-4\times2\times-2}}{2\times2}$ oe	**M1**	dep on previous M1 earned; for attempt at formula or full attempt at completing square, using their other factor	not more than two errors in formula / substitution / completing square; allow even if their 'factor' has a remainder shown in working; **M0** for just an attempt to factorise
	$\frac{-1\pm\sqrt{17}}{4}$ oe isw	**A1**		

3	(iii) $\frac{4}{x^2} = x + 2$ or $y = x + 2$ soi	**M1**	eg is earned by correct line drawn	condone intent for line; allow slightly out of tolerance;
	$y = x + 2$ drawn	**A1**		condone unruled; need drawn for $-1.5 \le x \le 1.2$; to pass through/touch relevant circle(s) on overlay
	1 real root	**A1**		

4	(i)(A) sketch of cubic correct way up and with two tps, crossing x-axis in 3 distinct points	**B1**	**0** if stops at x-axis; condone not crossing y-axis	No section to be ruled; no curving back; condone slight 'flicking out' at ends; condone some doubling (eg erased curves may continue to show)
	crossing x axis at 1, 2.5 and 4	**B1**	intersections labelled on graph or shown nearby in this part; mark intent for intersections with both axes (eg condone graphs stopping at axes)	allow 2.5 indicated by graph crossing halfway between their marked 2 and 3 on scale; allow if no graph but 0 if graph inconsistent with values
	crossing y axis at −20	**B1**	or $x = 0$, $y = -20$ seen in this part if consistent with graph drawn	allow if no graph, but eg **B0** for graph with intn on +ve y-axis or nowhere near their indicated −20

4	(i)(B) correct expansion of two brackets correct interim step(s) multiplying out linear and quadratic factors before given answer **or** showing that 1, 2.5 and 4 all satisfy f(x) = 0 for cubic in $2x^3$ ... form comparing coeffts of eg x^3 in the two forms	**M1** **M1** **or** **M1** **M1**	or **M2** for all 3 brackets multiplied at once, showing all 8 terms (**M1** if error in one term): $2x^3 - 8x^2 - 2x^2 - 5x^2 + 8x + x + 20x - 20$ **or** **M1** for dividing $2x^3$ ... form by one of the linear factors and **M1** for factorising the resultant quadratic factor	eg **M1** for $(2x - 5)(x^2 - 5x + 4)$ condone missing brackets if intent clear /used correctly
4	(ii)(A) 250 − 375 + 165 − 40 isw	**B1**	**or** showing that $x - 5$ is a factor by eg division and then stating that $x = 5$ is root or that g(5) = 0	'2 × 125 + 15 × 25 + 33 × 5 – 40' is not sufft **or** [g(5) =] f(5) – 20 = 5 × 4 × 1 – 20 [= 0]
4	(ii) ($x - 5$) seen or used as linear factor division by $(x - 5)$ as far as $2x^3 - 10x^2$ seen in working $2x^2 - 5x + 8$ obtained isw	**M1** **M1** **A1**	may be in attempt at division or inspection/equating coefficients with two terms correct eg $(2x^2 \ldots\ldots + 8)$ eg may be seen in grid; condone g(x) not expressed as product	allow if seen in (ii)(A) for division: condone signs of $2x^3 - 10x^2$ changed for subtraction, or subtraction sign in front of first term

4	(ii)(C) $b^2 - 4ac$ used on their quadratic factor $(-5)^2 - 4 \times 2 \times 8$ oe and negative [or -39] so no [real] root [may say only one [real] root, thinking of $x = 5$]	**M1** **A1**	may be in formula [or allow **2** marks for complete correct attempt at completing square and conclusion, or using calculus to show min value is above x-axis and comment re curve all above x-axis]	 no ft for A mark from wrong quadratic factor condone error in working out –39 if correct unsimplified expression seen and neg result obtained $-5^2 - 4 \times 2 \times 8$ evaluated correctly with comment is eligible for **A1**, otherwise bod for the **M1** only
4	(iii) translation $\begin{pmatrix} 0 \\ -20 \end{pmatrix}$	**B1** **B1**	NB ‘Moves’ not sufficient for this first mark or 20 down;	 **B0** for second mark if choice of one wrong, one right description