1	(i)	2	B1 for one soln	
	(ii) $y = (x - 2)^2 - 4$ or $y = x^2 - 4x$ o.e. isw	2	M1 if y omitted or for $y = (x + 2)^2 - 4$ or $y = x^2 + 4x$ o.e.	4

2	(i) ranslation	1		
	of $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$	1	or '2 to the right' or '$x \rightarrow x + 2$' or 'all x values are increased by 2'	
	(ii) $y = f(x - 2)$	2		4
			1 for $y = f(x + 2)$	

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3	(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	allow if no graph, but marked on *x*-axis condone intercepts for *x* and / or *y* given as reversed coordinates
					mark intent for intersections with both axes	
			crossing *y*-axis at 30	B1	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
				[3]		
3	(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	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
				[2]		

	Question		Answer	Marks	Guidance	Question
3	**(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]		
3	**(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]		

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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	**M1**	or **M2** for all 3 brackets multiplied at once, showing all 8 terms (**M1** if error in one term): $2x^3 - 8x^2 - 2x^2 - 5x^2 + 8x + x + 20x - 20$	eg **M1** for $(2x - 5)(x^2 - 5x + 4)$
	correct interim step(s) multiplying out linear and quadratic factors before given answer	**M1**		condone missing brackets if intent clear /used correctly
	or showing that 1, 2.5 and 4 all satisfy f(x) = 0 for cubic in $2x^3$ ... form	**or** **M1**	**or** **M1** for dividing $2x^3$ ... form by one of the linear factors and **M1** for factorising the resultant quadratic factor	
	comparing coeffts of eg x^3 in the two forms	**M1**		

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	'$2 \times 125 + 15 \times 25 + 33 \times 5 - 40$' is not sufft **or** [g(5) =] f(5) $- 20 = 5 \times 4 \times 1 - 20$ [$= 0$]
4	(ii) ($x - 5$) seen or used as linear factor	**M1**	may be in attempt at division	allow if seen in (ii)(A)
	division by $(x - 5)$ as far as $2x^3 - 10x^2$ seen in working	**M1**	or inspection/equating coefficients with two terms correct eg ($2x^2$ ….. $+ 8$)	for division: condone signs of $2x^3 - 10x^2$ changed for subtraction, or subtraction sign in front of first term
	$2x^2 - 5x + 8$ obtained isw	**A1**	eg may be seen in grid; condone g(x) not expressed as product	

4	(ii)(C) $b^2 - 4ac$ used on their quadratic factor	**M1**	may be in formula	
	$(-5)^2 - 4 \times 2 \times 8$ oe and negative [or -39] so no [real] root [may say only one [real] root, thinking of $x = 5$]	**A1**	[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