1	**i**	$y' = 6 - 2x$ $y' = 0$ used $x = 3$ $y = 16$	M1 M1 A1 A1	condone one error	
		(0, 7) (–1, 0) and (7,0) found or marked on graph	3	1 each	
		sketch of correct shape	1	must reach pos. y - axis	8
	ii	58.6 to 58.7	3 M1	B1 for $7x + 3x^2 - x^3/3$ [their value at 5] – [their value at 1] dependent on integration attempted	3
	iii	using his (ii) and 48	1		1

2	(i)		$\left[\frac{dy}{dx}=\right]4 \times 2 + 3$ or 11 isw	M1*		
			$9 =$ their $(4 \times 2 + 3) \times 2 + c$	M1dep*	or $y - 9 =$ their $(4 \times 2 + 3) \times (x - 2)$	
			$y = 11x - 13$ or $y = 11x + c$ and $c = -13$ stated isw	A1	or $y - 9 = 11(x - 2)$ isw	
				[3]		
2	(ii)		$\frac{4x^2}{2} + 3x$	M1*		
			$[y =]\ 2x^2 + 3x + c$	A1	must see "2" and " + c"; may be earned later eg after attempt to find c	
			$9 = 2\times2^2 + 3\times2 + c$	M1dep*	must include constant, which may be implied by answer	
			$y = 2x^2 + 3x - 5$ cao	A1	allow first 4 marks for $y = 2x^2 + 3x + c$ and $c = -5$ stated	
			(1, 0) *and* (–2.5, 0) oe cao	B1	or for $x = 1$, $y = 0$ and $x = -2.5$, $y = 0$	**B0** for just stating $x = 1$ and $x = -2.5$
			$x = -\frac{3}{4}$	B1		
			$y = -\frac{49}{8}$	B1	-6.125 or $-6\frac{1}{8}$	
				[7]		

2	**(iii)**		substitution to obtain [y =] f($2x$) in polynomial form	**M1**	f(x) must be the quadratic in x with linear and constant term obtained in part (ii), may be in factorised form	or their $x = 1 \rightarrow$ their 0.5 and their $x = -2.5 \rightarrow$ their $x = -1.25$
			$y = (2x - 1)(4x + 5)$ or $y = 8x^2 + 6x - 5$ or $y = 2\left(2x + \frac{3}{4}\right)^2 - \frac{49}{8}$	**A1FT**	must be simplified to one of these forms, **FT** their quadratic in x with linear and constant term obtained in part (ii)	hence $y = (2x - 1)(4x + 5)$ FT their x-intercepts from their quadratic in x with linear and constant term obtained in part (ii)
			$\left(-\frac{3}{8}, -\frac{49}{8}\right)$ oe	**B1** **[3]**	or **FT** their (both non-zero) co-ordinates for minimum point or their quadratic in x with linear and constant term obtained in part (ii)	

3	**i**	$(x + 5)(x - 2)(x + 2)$	2	M1 for $a\ (x + 5)(x - 2)(x + 2)$	2
	ii	$[(x + 2)](x^2 + 3x - 10)$	M1	for correct expansion of one pair of their brackets	
		$x^3 + 3x^2 - 10x + 2x^2 + 6x - 20$ o.	M1	for clear expansion of correct factors – accept given answer from $(x + 5)(x^2 - 4)$ as first step	2
	iii	$y' = 3x^2 + 10x - 4$ their $3x^2 + 10x - 4 = 0$ s.o.i. x = 0.36… from formula o.e.	M2 M1 A1	M1 if one error or M1 for substitution of 0.4 if trying to obtain 0, and A1 for correct demonstration of sign change	
		$(-3.7, 12.6)$	B1+1		6
	iv	$(-1.8, 12.6)$	B1+1	accept $(-1.9, 12.6)$ or f.t.(½ their max x, their max y)	2

4	(i) $\frac{x^4}{4} - x^3 - \frac{x^2}{2} + 3x$ their integral at 3 − their integral at 1 [= −2.25 − 1.75] = −4 isw represents area between curve and x axis between x = 1 and 3 negative since below x-axis	**M2** **M1** **A1** **B1** **B1**	**M1** if at least two terms correct dependent on integration attempted	ignore $+c$ M0 for evaluation of $x^3 - 3x^2 - x + 3$ or of differentiated version **B0** for area *under* or above curve between x = 1 and 3
4	(ii) $y' = 3x^2 - 6x - 1$ their y' = 0 soi $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ with a = 3, b = -6 and c = -1 isw $x = \frac{6 \pm \sqrt{48}}{6}$ or better as final answer $\frac{6-\sqrt{48}}{6} < x < \frac{6+\sqrt{48}}{6}$ or ft their final answer	**M1** **M1** **M1** **A1** **B1**	 dependent on differentiation attempted or $3(x-1)^2$ - 4 [= 0] or better eg **A1** for $1 \pm \frac{2}{3}\sqrt{3}$ allow ≤ instead of <	 no follow through; NB $\frac{6 \pm \sqrt{48}}{6}$ or better stated without working implies use of correct method **A0** for incorrect simplification, eg 1 ± √48 allow **B1** if *both* inequalities are stated separately and it's clear that both apply allow **B1** if the terms and the signs are in reverse order

5	(i)	$3x^2 - 6x - 9$ use of their $y' = 0$ $x = -1$ $x = 3$ valid method for determining nature of turning point max at $x = -1$ and min at $x = 3$	M1 M1 A1 A1 M1 A1	c.a.o.	6
	(ii)	$x(x^2 - 3x - 9)$ $\frac{3 \pm \sqrt{45}}{2}$ or $(x - \frac{3}{2})^2 = 9 + \frac{9}{4}$ $0, \frac{3}{2} \pm \frac{\sqrt{45}}{2}$ o.e.	M1 M1 A1		3
	(iii)	sketch of cubic with two turning points correct way up x-intercepts – negative, 0, positive shown	G1 DG1		2

6	**i**	$y' = 3x^2 - 12x$ use of $y' = 0$ $x = 0$ and 4 (0, 12) and (4, –20) $y'' = 6x - 12$ used max when $x = 0$, min when $x = 4$	B1B1 M1 A1 A1 M1 A1	 Allow y = 12 and y = -20 y' used each side of TP or good sketch Both stated, only one needs testing	 7
	ii	when $x = 2$ $y' = -12$ grad of normal = 1/12 $y + 4 = 1/12(x - 2)$ $y = \frac{1}{12}x - 4\frac{1}{6}$	B1 B1ft M1ft A1	 from their y' accept any numerical m Or -4 = their(m) x 2 + c Any recognisable 25/6, at worst 4.1	 4 **[11]**