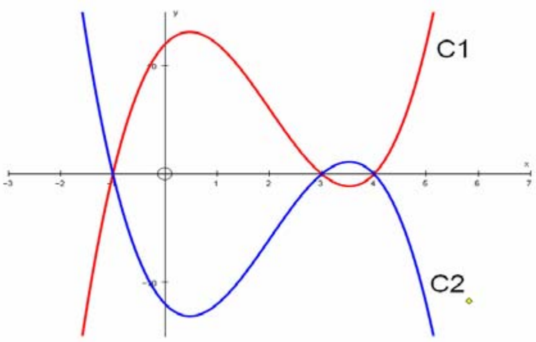
1	(i)	$\frac{21-3}{4-1}=\frac{18}{3}=6$	M1		Uses $\frac{y_2-y_1}{x_2-x_1}$
			A1	2	6 (not left as $\frac{18}{3}$)
	(ii)	$\frac{dy}{dx}=2x+1$	B1		
		$2\times 3+1=7$	B1	2	
2	(i)	$27^{-\frac{2}{3}}=\frac{1}{27^{\frac{2}{3}}}=\frac{1}{9}$	M1		$\frac{1}{27^{\frac{2}{3}}}$ or $27^{\frac{2}{3}}=9$ or 3^{-2} soi
			A1	2	$\frac{1}{9}$
	(ii)	$5\sqrt{5}=5^{\frac{3}{2}}$	B1	1	
	(iii)	$\frac{1-\sqrt{5}}{3+\sqrt{5}}=\frac{(1-\sqrt{5})(3-\sqrt{5})}{(3+\sqrt{5})(3-\sqrt{5})}$	M1		Multiply numerator and denominator by conjugate
		$=\frac{8-4\sqrt{5}}{4}$	B1		$(\sqrt{5})^2=5$ soi
		$=2-\sqrt{5}$	A1	3	$2-\sqrt{5}$
3	(i)	$2x^2+12x+13=2(x^2+6x)+13$	B1		$a=2$
		$=2[(x+3)^2-9]+13$	B1		$b=3$
		$=2(x+3)^2-5$	M1		$13-2b^2$ or $13-b^2$ or $\frac{13}{2}-b^2$ (their b)
			A1	4	$c=-5$
	(ii)	$2(x+3)^2-5=0$	M1		Uses correct quadratic formula or completing square method
		$(x+3)^2=\frac{5}{2}$	A1		$x=\frac{-12\pm\sqrt{40}}{4}$ or $(x+3)^2=\frac{5}{2}$
		$x=-3\pm\sqrt{\frac{5}{2}}$	A1	3	$x=-3\pm\sqrt{\frac{5}{2}}$ or $-3\pm\frac{1}{2}\sqrt{10}$

4	(i)	$(x-4)(x-3)(x+1)$ $\equiv (x^2-7x+12)(x+1)$ $\equiv x^3+x^2-7x^2-7x+12x+12$ $\equiv x^3-6x^2+5x+12$	B1 M1 A1	 3	$x^2-7x+12$ or x^2-2x-3 or x^2-3x-4 seen Attempt to multiply a quadratic by a linear factor or attempt to list an 8 term expansion of all 3 brackets $x^3-6x^2+5x+12$ **(AG)** obtained (no wrong working seen)
	(ii) (iii)		B1 B1 B1 M1 A1√	 3 2	+ve cubic with 3 roots (not 3 line segments) (0, 12) labelled or indicated on y-axis (– 1, 0), (3,0), (4, 0) labelled or indicated on x-axis Reflect *their* (ii) in either x- or y-axis Reflect *their* (ii) in x-axis
5	(i)	$1<4x-9<5$ $10<4x<14$ $2.5<x<3.5$	M1 A1 A1	 3	2 equations or inequalities both dealing with all 3 terms 2.5 and 3.5 seen oe $2.5 < x < 3.5$ (or '$x > 2.5$ <u>and</u> $x < 3.5$')
	(ii)	$y^2 \geq 4y+5$ $y^2-4y-5\geq 0$ $(y-5)(y+1)\geq 0$ $y\leq -1,\ y\geq 5$	B1 M1 A1 M1 A1	 5	$y^2-4y-5=0$ soi Correct method to solve quadratic -1, 5 (**SR** If **both** values obtained from trial and improvement, award **B3**) Correct method to solve inequality $y\leq -1,\ y\geq 5$

6	(i)	$x^4-10x^2+25=0$ Let $y=x^2$ $y^2-10y+25=0$ $(y-5)^2=0$ $y=5$ $x^2=5$ $x=\pm\sqrt{5}$	*M1 dep*M1 A1 A1	 4	Use a substitution to obtain a quadratic or $(x^2-5)(x^2-5)=0$ Correct method to solve a quadratic 5 (not x = 5 with no subsequent working) $x=\pm\sqrt{5}$
	(ii)	$y=\dfrac{2x^5}{5}-\dfrac{20x^3}{3}+50x+3$ $\dfrac{dy}{dx}=2x^4-20x^2+50$	B1 B1	 2	$2x^4$ or $-20x^2$ oe seen $2x^4-20x^2+50$ (integers required)
	(iii)	$2x^4-20x^2+50=0$ $x^4-10x^2+25=0$ which has 2 roots	M1 A1	 2	*their* $\dfrac{dy}{dx}=0$ seen (or implied by correct answer) 2 stationary points **www in any part**
7	(i)	$y=x^2-5x+4$ $y=x-1$ $x^2-5x+4=x-1$ $x^2-6x+5=0$ $(x-1)(x-5)=0$ $x=1 \quad x=5$ $y=0 \quad y=4$	M1 M1 A1 A1	 4	Substitute to find an equation in *x* (or *y*) Correct method to solve quadratic *x* = 1, 5 *y* = 0, 4 (**N.B.** This final A1 may be awarded in part (ii) if y coordinates only seen in part (ii)) **SR** one correct (*x*,y) pair **www** **B1**
	(ii)	2 points of intersection	B1	1	
	(iii)	EITHER $x^2-5x+4=x+c$ has 1 solution $x^2-6x+(4-c)=0$ $b^2-4ac=0$ $36-4(4-c)=0$ $c=-5$ OR $\dfrac{dy}{dx}=1=2x-5$ $x=3 \quad y=-2$ $-2=3+c$ $c=-5$	 M1 M1 A1 A1 M1 A1 A1 A1	 4 4	$x^2-5x+4=x+c$ has 1 soln seen or implied Discriminant = 0 or $(x-a)^2=0$ soi 36 – 4(4 – *c*) = 0 or 9 = 4 – *c* *c* = – 5 Algebraic expression for gradient of curve = non-zero gradient of line used 2*x* – 5 = 1 *x* = 3 *c* = –5 **SR** *c* = -5 without any working **B1**

8	(i)	Height of box = $\frac{8}{x^2}$	*B1		Area of 1 vertical face $=\frac{8}{x^2}\times x$ $=\frac{8}{x}$
		4 vertical faces $=4\times\frac{8}{x}$ $=\frac{32}{x}$	*B1		
		Total surface area = $x^2+x^2+\frac{32}{x}$	B1 dep on both **		Correct final expression
		$A=2x^2+\frac{32}{x}$		3	
	(ii)	$\frac{dA}{dx}=4x-\frac{32}{x^2}$	B1 B1 B1	3	$4x$ kx^{-2} $-32x^{-2}$
	(iii)	$4x-\frac{32}{x^2}=0$	M1		$\frac{dA}{dx}=0$ soi
		$4x^3=32$ $x=2$	A1		$x = 2$
			M1 A1	4	Check for minimum Correctly justified
					SR If $x = 2$ stated **www** but with no evidence of differentiated expression(s) having been used in part (iii) **B1**

9	(i)	$\left(\frac{4+10}{2}, \frac{-2+6}{2}\right)$	M1		Uses $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$
		(7, 2)	A1	2	(7, 2) (integers required)
	(ii)	$\sqrt{(7-4)^2+(2--2)^2}$	M1		Uses $\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$
		$=\sqrt{3^2+4^2}$ $=5$	A1	2	5
	(iii)	$(x-7)^2+(y-2)^2=25$	B1√		$(x-7)^2$ and $(y-2)^2$ used (*their* centre)
			B1√		$r^2 = 25$ used (*their* r^2)
			B1	3	$(x-7)^2+(y-2)^2=25$ cao <u>Expanded form:</u> $-14x$ and $-4y$ used B1√ $r = \sqrt{g^2+f^2-c}$ used B1√ $x^2+y^2-14x-4y+28=0$ B1 cao <u>By using ends of diameter:</u> $(x - 4)(x - 10) + (y + 2)(y - 6) = 0$ Both x brackets correct B1 Both y brackets correct B1 Final equation fully correct B1
	(iv)	Gradient of AB = $\frac{6--2}{10-4}=\frac{4}{3}$	B1		oe
		Gradient of tangent = $-\frac{3}{4}$	B1√		
			M1		Correct equation of straight line through A, any non-zero gradient
		$y--2=-\frac{3}{4}(x-4)$	A1		
		$3x+4y=4$	A1	5	a, b, c need not be integers