

Question			Answer	Marks	AO	Guidance	
7	(a)		$(y =) k(x \pm 3)^2 \pm 16$ $0 = k(1 - 3)^2 - 16 \Rightarrow k = \dots$ $y = 4(x - 3)^2 - 16 \Rightarrow y = 4(x^2 - 6x + 9) - 16$ so $f(x) = 4x^2 - 24x + 20$ or $y = 4x^2 - 24x + 20$	M1*	2.1	Using the given minimum point $(3, -16)$ to form an expression with (unknown) constant k with $k \neq 1$	If correct $k = 4$
				M1dep*	1.1	Using $(1, 0)$ to find k	
				A1	1.1	AG – sufficient working must be shown	
			Alternative method 1 $(y =) ax^2 + bx + c$ $(y' =) 2ax + b$ therefore $2a(3) + b = 0$ Either $a + b + c = 0$ or $a(3)^2 + 3b + c = -16$ Solving correctly leading to $a = 4, b = -24, c = 20$	M1		Using the fact that the minimum point is when $x = 3$ to obtain an equation in a and b	Allow a single slip when differentiating
				B1		A correct equation in a, b and c using either $(1, 0)$ or $(3, -16)$	
				A1		AG – sufficient working must be shown	
			Alternative method 2 $4 - 24 + 20 = 0$ (therefore, the curve passes through the point $(1, 0)$) $(y' =) 8x - 24$ and at a stationary point $y' = 0$ therefore $8x - 24 = 0$ leading to $x = \dots$ $x = 3 \Rightarrow y = 4(3)^2 - 24(3) + 20$ so $y = -16$	B1		Convincingly showing that the given curve passes through $(1, 0)$	Allow a single slip when differentiating
				M1		Differentiate given equation, set equal to zero and solve for x	
				A1		AG – convincingly show that there is a stationary point at $(3, -16)$	

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			Alternative method 3 $y = 4x^2 - 24x + 20$ $= 4[x^2 - 6x] + 20$ $= 4[(x - 3)^2 - 9] + 20$ $= 4(x - 3)^2 - 36 + 20$ $= 4(x - 3)^2 - 16$ so, there is a stationary point at $(3, -16)$ $4 - 24 + 20 = 0$ (therefore, the curve passes through the point $(1, 0)$)	M1 A1 B1		Attempt to complete the square on given quadratic Also possible to obtain $(2x - 6)^2 - 16$ Correctly showing that $(3, -16)$ is a stationary point on the curve Convincingly showing that the given curve passes through $(1, 0)$	Allow sign errors only or $4(1 - 3)^2 - 16 = 16 - 16 = 0$
			Alternative method 4 The (quadratic) curve crosses the axis where $x = 5$ $y = k(x - 1)(x - 5)$ $-16 = k(3 - 1)(3 - 5) \Rightarrow k = \dots$ $k = 4 \Rightarrow y = 4(x - 1)(x - 5)$ $y = 4(x^2 - 6x + 5)$ $y = 4x^2 - 24x + 20$	B1 M1 A1		soi eg by symmetry Substitutes $(3, -16)$ in an equation of the form $y = k(x - 1)(x - a)$ to find k AG – sufficient working must be shown	Where $k \neq 1$ and $k > 0$ and $a > 3$
				[3]			

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7	(b)		Curve also intersects the x-axis at 5 $\int 4x^2 - 24x + 20 \, dx$ $= \frac{4}{3}x^3 - \frac{24}{2}x^2 + 20x \, (+c)$ $\left(\frac{4}{3}a^3 - 12a^2 + 20a\right) - \left(\frac{4}{3}(5)^3 - 12(5)^2 + 20(5)\right)$ $= \frac{100}{3}$ $a^3 - 9a^2 + 15a = 0 \text{ so } (a = 0 \text{ or}) a = \frac{9 \pm \sqrt{21}}{2}$ $a = \frac{9 + \sqrt{21}}{2} \text{ as } a > 5$	B1 M1* A1 M1dep* M1 A1 [6]	3.1a 1.1 1.1 2.1 1.1 3.2a	BC or by symmetry/inspection Attempt to integrate – at least one term with power increased by 1 and a change in coefficient of that term. Correct integration (allow unsimplified) Set up a cubic equation in a using correct limits and the given $\frac{100}{3}$ BC solves their 3 (or 4) term cubic – if correct equation then allow the stating of only the correct value for this mark. If incorrect cubic then must state all possible real roots for this mark. Can be awarded for inexact solutions Correct exact root together with justification.	Ignore limits for the first M1 A1 SC $\int x^2 - 6x + 5 \, dx$ scores B1M1*M1dep*M1 max 4 out of 6 Must be applying limits correctly (but allow one slip) Dependent on both previous M marks If correct $a = 0$, 6.7912 ..., 2.20871 ...