Question			Answer	Marks	Guidance	
1	(i)		$y' = 1 + 8x^{-3}$ $y'' = -24x^{-4}$ oe	M2 A1 **[3]**	M1 for just $8x^{-3}$ or $1 - 8x^{-3}$	but not just $\frac{-24}{x^4}$ as AG
1	(ii)		their $y' = 0$ soi $x = -2$ $y = -3$ substitution of $x = -2$: $\frac{-24}{(-2)^4}$ < 0 or $= -1.5$ oe correctly obtained isw	M1 A1 A1 M1 A1 **[5]**	 A0 if more than one x-value A0 if more than one y-value or considering signs of gradient either side of -2 with negative x-values signs for gradients identified to verify maximum	 $x = -2$ must have been correctly obtained for all marks after first M1 condone any bracket error must follow from M1 A1 A0 M1 or better
1	(iii)		$y = -5$ soi substitution of $x = -1$ in their y' grad normal $= {}^{-1}/_{\text{their} - 7}$ $y -$ their$(-5) =$ their ${}^{1}/_{7}(x - -1)$ $-x + 7y + 34 = 0$ oe	B1 M1 M1* M1dep* A1 **[5]**	 may be implied by -7 may be implied by eg ${}^{1}/_{7}$ or their $(-5) =$ their ${}^{1}/_{7} \times (-1) + c$ allow eg $y - \frac{1}{7}x + \frac{34}{7} = 0$	 must see $= 0$ do not allow eg $y = \frac{x}{7} - \frac{34}{7}$

Question			Answer	Marks	Guidance	
2	(i)		$3x^2 - 6x - 22$	**M1**	condone one incorrect term, but must be three terms	condone "$y =$"
			their $y' = 0$ soi	**M1**	at least one term correct in their y'	may be implied by use of eg quadratic formula, completing square, attempt to factorise
			3.89 −1.89	**A1** **A1**	if **A0A0**, **SC1** for $\frac{3 \pm 5\sqrt{3}}{3}$ or $1 \pm {}^{5}/_{\sqrt{3}}$ or better, or both decimal answers given to a different accuracy or from truncation	3.886751346 and −1.886751346
				[4]		
2	(ii)		$x^3 - 3x^2 - 22x + 24 = 6x + 24$ $x^3 - 3x^2 - 28x$ [= 0]	**M1** **M1**	may be implied by $x^3 - 3x^2 - 28x$ [= 0] may be implied by $x^2 - 3x - 28$[= 0]	
			other point when $x = 7$ isw	**A1** **[3]**	dependent on award of both **M** marks	ignore other values of x
2	(iii)		F[x] = $\frac{x^4}{4} - \frac{3x^3}{3} - \frac{22x^2}{2} + 24x$	**M1***	allow for three terms correct; condone $+ c$	**alternative method** **M1** for $\int((x^3 - 3x^2 - 22x + 24) - (6x + 24))dx$ may be implied by 2nd **M1**
			F[0] – F[−4]	**M1dep**	allow 0 – F[−4], condone – F[−4], but do not allow F[−4] only	**M1*** for F[x] = $\frac{x^4}{4} - \frac{3x^3}{3} - \frac{28x^2}{2}$ condone one error in integration
			area of triangle = 48	**B1**		**M1dep** for F[0] – F[−4]
			area required = 96 from fully correct working	**A1** **[4]**	**A0** for – 96, ignore units,	no marks for 96 unsupported

3	(i) $200 - 2\pi r^2 = 2\pi rh$ $h = \frac{200 - 2\pi r^2}{2\pi r}$ o.e. substitution of correct h into $V = \pi r^2 h$ $V = 100r - \pi r^3$ convincingly obtained	**M1** **M1** **M1** **A1**	$100 = \pi r^2 + \pi rh$ $100r = \pi r^3 + \pi r^2 h$ $100r = \pi r^3 + V$ $V = 100r - \pi r^3$ or **M1 f**or $h = \frac{V}{\pi r^2}$ **M1** for $200 = 2\pi r^2 + 2\pi r \times \frac{V}{\pi r^2}$ **M1** for $200 = 2\pi r^2 + 2\frac{V}{r}$ **A1** for $V = 100r - \pi r^3$ convincingly obtained	**sc3** for complete argument working backwards: $V = 100r - \pi r^3$ $\pi r^2 h = 100r - \pi r^3$ $\pi rh = 100 - \pi r^2$ $100 = \pi rh + \pi r^2$ $200 = A = 2\pi rh + 2\pi r^2$ **sc0** if argument is incomplete
3	(ii) $\frac{dV}{dr} = 100 - 3\pi r^2$ $\frac{d^2V}{dr^2} = -6\pi r$	**B2** **B1**	**B1** for each term	allow $9.42(\ldots) r^2$ or better if decimalised $-18.8(\ldots) r$ or better if decimalised
3	(iii) their $\frac{dV}{dr} = 0$ s.o.i. $r = 3.26$ c.a.o. $V = 217$ c.a.o.	**M1** **A2** **A1**	must contain r as the only variable **A1** for $r = (\pm)\sqrt{\frac{100}{3\pi}}$; may be implied by 3.25… deduct 1 mark only in this part if answers not given to 3 sf,	there must be evidence of use of calculus

4 (i)	$3x^2 - 12x - 15$	**2**	**M1** if one term incorrect or an extra term is included.

4 (ii)	Their $\frac{dy}{dx} = 0$ s.o.i. $x = 5$ $x = -1$	**M1** **B1** **B1**	

5	$y' = 3x^2 - 12x - 15$ use of $y' = 0$, s.o.i. ft $x = 5, -1$ c.a.o. $x < -1$ or $x > 5$ f.t.	M1 M1 A1 A1 A1	for two terms correct	5