Question	Scheme	Marks	AOs
9 (a)	Equating the two curves, leading to finding a value for at least one of the limits $18 - 2x^2 = 12 - \frac{1}{2}x^2 \Rightarrow x =$	M1	1.1b
	$x = -2$ **and** $x = 2$	A1	1.1b
		(2)	
(b)	$\{V =\}\ \pi \int_{-2}^{2} \left[(18 - 2x^2)^2 - \left(12 - \frac{1}{2}x^2\right)^2 \right] \mathrm{d}x$	B1	1.1a
	Integrates to an expression of the form $ax^5 \pm bx^3 \pm cx$	M1	1.1b
	Correct integration $\frac{3}{4}x^5 - 20x^3 + 180x$	A1	1.1b
	Uses their y limits correctly in a changed expression $\pi \left[\frac{3}{4}x^5 - 20x^3 + 180x \right]_{-2}^{2}$ $= \pi \left[\left(\frac{3}{4}(2)^5 - 20(2)^3 + 180(2) \right) \right.$ $\left. - \left(\frac{3}{4}(-2)^5 - 20(-2)^3 + 180(-2) \right) \right]$ $= \dots \{448\pi$ or $1407.43\dots$ (mm³)$\}$	M1 A1	3.4 1.1b
	Number rings $= 1000 \div ('\text{their volume}' \times 18 \div 1000)$	M1	3.1b
	39 (rings)	A1	2.2b
		(7)	
		(9 marks)	

Notes:

(a)

M1: Equates the two curves leading to finding a value or values for x

A1: Both x coordinates correct.

(b)

B1: Sets up the model to find a correct expression for the volume, including limits, $\mathrm{d}x$ may be implied. The limits may be seen later.

M1: Integrates to the form $ax^5 \pm bx^3 \pm cx$

A1: Correct integration.

M1: Substitutes their limits the correct way round and subtracts, must be a changed expression.

   They may use $2\int_{0}^{2} \dots$ or $\int_{-2}^{0} \dots + \int_{0}^{2} \dots$ etc

A1: Volume of 448π or awrt 1400 (mm³)

M1: Finds the mass of one ring by changing to cm³ and multiplying by 18, then divides 1kg by their answer, to find the number of rings.

A1: 39 cao (do not accept 39.47..)