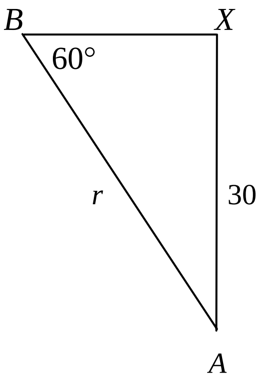
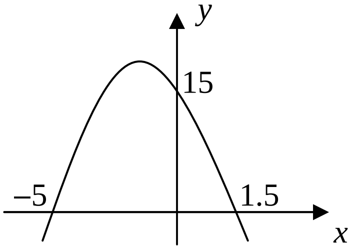
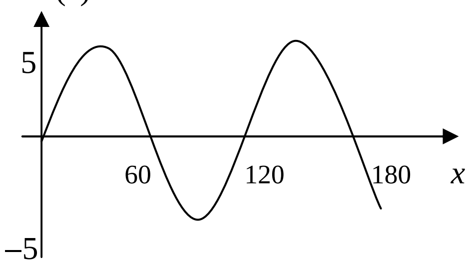
Question Number	Scheme	Marks
1. (*a*)	$1 \times 7 + 2 \times 7 + \ldots \quad a = 7, d = 7, n = 142$ $n = 142$	B1
	$S_n = \frac{1}{2}n(a+b)$ or $\frac{1}{2}n(2a + (n-1)d)$ or $7 \times \frac{n(n+1)}{2}$	M1 (use of correct formula)
	$= \frac{142}{2}(7 + 994)$ or $\frac{142}{2}(14 + 141 \times 7)$ or $7 \times \frac{142 \times 143}{2} = \mathbf{71\,071}$	A1 **(3)**
(*b*)	$\sum_{r=1}^{142}(7r+2) = \sum_{r=1}^{142}7r + \sum_{r=1}^{142}2$ split	M1
	$\sum_{r=1}^{142}2 = 2 \times 142$	
	$\therefore \sum_{r=1}^{142}(7r+2) = 71\,071 + 2 \times 142 = \mathbf{71\,355}$	A1 **(3)**
		(6 marks)
2. (*a*)	 $\sin 60° = \frac{3}{r}$ or $r = 2x, 4x^2 = x^2 + 3^2, x = \sqrt{3}$	M1
	$\boldsymbol{r = \frac{6}{\sqrt{3}}}$ or $\boldsymbol{r = 2\sqrt{3}}$	A1 **(2)**
(*b*)	Area $= \frac{1}{2}r^2\theta^c$ or $\frac{\theta°}{360°} \times \pi r^2 = , \frac{1}{6} \times \pi \times 12 = \mathbf{2\pi}$ (cm^2)	M1, A1 **(2)**
(*c*)	Arc $= r^2\theta^c$ or $\frac{\theta°}{360°} \times 2\pi r = , \frac{1}{6} \times 2\pi \times 2\sqrt{3}$	M1
	Perimeter = Arc + $2r$ = , $\frac{2\sqrt{3}}{3}\pi + 2 \times 2\sqrt{3} = \boldsymbol{\frac{2\sqrt{3}}{3}(\pi + 6)}$ (cm) (✱)	M1, A1 cso **(3)**
		(7 marks)

Question Number	Scheme	Marks
3. (*a*)	$f(x) = 0 \Rightarrow 2x^2 + 7x - 15 = 0$	
	$(2x - 3)(x + 5) = 0$ attempt to solve $f(x) = 0$	M1
	$\therefore$ points are $\mathbf{(\frac{3}{2}, 0), (-5, 0)\ ; (0, 15)}$	A1 (both); B1 **(3)**
(*b*)		
	shape	B1
	vertex in correct quadrant	B1 ft **(2)**
(*c*)	Symmetry: $x = \frac{1}{2}(-5 + 1.5)$ or Calculus: $-7 - 4x = 0$ or Algebra: $-2[(x + \frac{7}{4})^2 - k]$	M1
	$\Rightarrow \boldsymbol{x = -\frac{7}{4},\ y = 21\frac{1}{8}}$	A1, A1 **(3)**
		(8 marks)
4. (*a*)	$(x + k)^2 - 7 - k^2 = 0$ $(x + k)^2$ (LHS)	M1 A1
	$\Rightarrow (x + k)^2 = 7 + k^2 = 0 \quad \therefore x + k = (\pm)\sqrt{7 + k^2}$	M1 (no need for ±)
	$\therefore \boldsymbol{x = -k \pm \sqrt{7 + k^2}}$	A1 (both) **(4)**
(*b*)	$7 + k^2 > 0$ (or discriminant > 0)	M1
	$\therefore$ roots are real and distinct	A1 **(2)**
(*c*)	$k = \sqrt{2} \quad \Rightarrow x = -\sqrt{2} \pm \sqrt{7 + 2}$	M1
	$\boldsymbol{x = -\sqrt{2} + 3}$ **or** $\boldsymbol{-\sqrt{2} - 3}$	A1 (both) **(2)**
		(8 marks)

Question Number	Scheme	Marks
5. (*a*)	 shape 60, 120, 180 on x-axis 5, –5 on y-axis (may be implied by part (*b*))	B1 B1 B1 **(3)**
(*b*)	**(30°, 5); (150°, 5); (90°, –5)** one x-coordinate all x-coordinates all correct	B1 B1 B1 **(3)**
(*c*)	$\text{f}(x) = 2.5 \Rightarrow \sin 3x° = \frac{1}{2}$ $3x = 30$ (150, 390, 510) one correct value $3x = (\alpha)$, $180 - \alpha$, $360 + \alpha$, $(540 - \alpha)$ $\boldsymbol{x = 10, 50, 130, 170}$	 B1 M1, M1 A1 (ignore extras out of range) **(4)** **(10 marks)**
6. (*a*)	$2x^{\frac{3}{2}} - 3x^{-\frac{3}{2}} = 0$ $x^3 = \frac{3}{2}$ $x = \sqrt[3]{\frac{3}{2}}$ $x = \sqrt[3]{\alpha}$ $= 1.1447\ldots \quad = \mathbf{1.14}$ (3 sf)	M1 M1 A1 cao **(3)**
(*b*)	$\text{f}(x) = 4x^3 + 9x^{-3} - 12 + 5$ ***A* = 4** $= 4x^3 + \dfrac{9}{x^3} - 7$ ***B* = 9, *C* = –7**	B1 B1, B1 **(3)**
(*c*)	$\int_1^2 \text{f}(x)\ \text{d}x = \left[x^4 - \frac{9}{2}x^{-2} - 7x\right]_1^2$ $x^n \to x^{n+1}$ $= (2^4 - \frac{9}{2} \times 2^{-2} - 14) - (1 - \frac{9}{2} - 7)$ [2] – [1] $= \mathbf{11\frac{3}{8}}$ or **11.375**	M1 A2 ft (candidate's *A B*, *C*) (–1 eeoo) M1 (use of limits) A1 **(5)** **(11 marks)**

Question Number	Scheme	Marks
7. (*a*)	$l = (50 - 2x)$ $w = (40 - 2x)$	B1
	$V = x(50 - 2x)(40 - 2x)$ $V = xlw$	M1
	$V = x(2000 - 80x - 100x + 4x^2)$ = $\mathbf{4x(x^2 - 45x + 500)}$ (✱)	A1 cso **(3)**
(*b*)	$\mathbf{0 < x < 20}$ (accept ≤)	B1 **(1)**
(*c*)	$\frac{dV}{dx} = 12x^2 - 360x + 2000$ (accept ÷ 4)	M1, A1
	$\frac{dV}{dx} = 0 \Rightarrow 3x^2 - 90x + 500 = 0 \Rightarrow x = \frac{90 \pm \sqrt{8100 - 6000}}{6}$	M1 (dV/dx = 0 & attempt to solve)
	$x = (22.6)$, **required x = 7.36 or 7.4 or 7.362**	A1 **(4)**
(*d*)	$V_{max} = 4 \times 7.36(7.36^2\ldots)$, = **6564 or 6560 or 6600**	M1, A1 **(2)**
(*e*)	e.g. $V'' = 24x - 360 \,\big\|_{x = 7.36}$ $(= -183\ldots) < 0$, ∴ maximum	M1 full method A1 full accuracy **(2)**
		(12 marks)
8. (*a*)	Mid-point of $AB = [\frac{1}{2}(-3 + 8), \frac{1}{2}(-2 + 4)]$, = $\mathbf{(\frac{5}{2}, 1)}$	M1, A1 **(2)**
(*b*)	$M_{AB} = \frac{4 - (-2)}{8 - (-3)}$, $= \frac{6}{11}$	M1, A1
	Equation of AB: $y - 4 = \frac{6}{11}(x - 8)$	M1
	$\Rightarrow 11y - 44 = 6x - 48$, $\Rightarrow$ $\mathbf{6x - 11y - 4 = 0}$ (or equivalent)	A1 **(4)**
(*c*)	Gradient of tangent = $-\frac{11}{6}$	B1 ft
	Equation: $\mathbf{y - 4 = -\frac{11}{6}(x - 8)}$ (or $6y + 11x - 112 = 0$)	M1 A1 **(3)**
(*d*)	Equation of l: $y = \frac{2}{3}x$	B1
	Substitute into part (*c*): $\frac{2}{3}x - 4 = -\frac{11}{6}x + \frac{88}{6}$	M1
	$\Rightarrow$ $\mathbf{x = 7\frac{7}{15}, \; y = 4\frac{44}{45}}$	A1, A1 **(4)**
		(13 marks)