1	$(x + 1)(x - 2)$ or other valid method $-1, 2$ $x < -1, x > 2$	M1 A1 A1 [3]	Attempt soln of eqn or other method Penalise $\leq, \geq$
2	$f(x) = 2x^{-\frac{1}{2}} + x\ (+c)$ $5 = -2 \times \frac{1}{2} + 4 + c$ $c = 2$	M1A1 M1 A1 [4]	Attempt integ $x^{-\frac{1}{2}}$ or $+x$ needed for M Sub (4, 5). c must be present
3	**(i)** gradient of perpendicular = –½ soi $y - 1 = -\frac{1}{2}(x - 3)$	B1 B1 [2]	
	(ii) $C = (-9, 6)$ $AC^2 = [3 - (-9)]^2 + [1 - 6]^2$ (ft on *their C*) $AC = 13$	B1 M1 A1 [3]	soi in **(i)** or **(ii)** **OR** $AB^2 = [3-(-21)]^2 + [1-11]^2$ M1 $AB = 26$ A1 $AC = 13$ A1
4	**(i)** **OD** = 4**i** + 3**j** **CD** = 4**i** + 3**j** –10**k**	B1 B1√ [2]	√ for **OD** – **10k**
	(ii) **OD.CD** = 9 + 16 = 25 $\lvert\mathbf{OD}\rvert = \sqrt{25}$ or $\lvert\mathbf{CD}\rvert = \sqrt{125}$ $25 = \sqrt{25} \times \sqrt{125} \times \cos\theta$ oe ODC = 63.4° (or 1.11 rads)	M1 M1 M1 A1 [4]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ Correct method for moduli All connected correctly cao
5	**(a)** $\frac{a}{1-r} = 8a \Rightarrow 1(a) = 8(a)(1-r)$ $r = \frac{7}{8}$ oe	B1 B1 [2]	
	(b) $a + 4d = 197$ $\frac{10}{2}[2a + 9d] = 2040$ $d = 14$	B1 B1 M1A1 [4]	Or $2a + 9d = 408$ Attempt to solve simultaneously
6	**(i)** sector areas are $\frac{1}{2}11^2\alpha, \frac{1}{2}5^2\alpha$ $k = \frac{\frac{1}{2} \times 11^2\alpha - \frac{1}{2} \times 5^2\alpha}{\frac{1}{2} \times 5^2\alpha}$ $k = \frac{96}{25}$ or 3.84	B1 M1 A1 [3]	Sight of $11^2, 5^2$ Or $\frac{11^2 - 5^2}{5^2}$

	(ii) perimeter shaded region= $11\alpha + 5\alpha + 6 + 6 = 16\alpha + 12$ perimeter unshaded region = $5\alpha + 5 + 5 = 5\alpha + 10$ $16\alpha + 12 = 2(5\alpha + 10)$ $\alpha = 4/3$ or 1.33	B1 B1 M1 A1 [4]	
7	**(a)** $x^2 - 1 = \sin\frac{\pi}{3}$ $x = \pm 1.366$	M1 A1A1√ [3]	√ for negative of 1st answer
	(b) $2\theta + \frac{\pi}{3} = \frac{5\pi}{6}\left(\text{or } \frac{13\pi}{6} \text{ or } \frac{\pi}{6}\right)$ $2\theta = \frac{\pi}{2} = \left(\text{or } \frac{11\pi}{6}\right)$ $\theta = \frac{\pi}{4}, \frac{11\pi}{12}$	B1 M1 A1A1 [4]	1 correct angle on RHS is sufficient Isolating 2θ SC decimals 0.785 & 2.88 scores M1B1
8	**(i)** 81 (x^8)	B1 [1]	
	(ii) 10×3^3 (x^8) soi leading to their answer 270 (x^8)	B1B1 B1 [3]	B1 for 10, 5C2 or 5C3. B1 for 3^3. But must be multiplied.
	(iii) k × **(i)** 405 soi + **(ii)** 675 (x^8)	M1 A1 DM1 A1 [4]	$k \neq 1,0$
9	$\frac{dy}{dx} = -k^2(x+2)^{-2} + 1 = 0$ $x + 2 = \pm k$ $x = -2 \pm k$ $\frac{d^2y}{dx^2} = 2k^2(x+2)^{-3}$ When $x = -2 = k$, $\frac{d^2y}{dx^2} = \left(\frac{2}{k}\right)$ which is (> 0) min When $x = -2 - k$, $\frac{d^2y}{dx^2} = \left(\frac{2}{-k}\right)$ which is (< 0) max	M1A1 DM1 A1 M1 M1 A1 A1 [8]	Attempt differentiation & set to zero Attempt to solve cao Attempt to differentiate again Sub their x value with k in it into $\frac{d^2y}{dx^2}$ Only 1 of bracketed items needed for each but $\frac{d^2y}{dx^2}$ and x need to be correct.

10	**(i)** Range is (y) $\geq c^2 + 4c$	B1	Allow >
	$x^2 + 4x = (x+2)^2 - 4$	M1	**OR** $\frac{dy}{dx} = 2x + 4 = 0$
	(Smallest value of c is) -2	A1 [3]	-2 with no (wrong) working gets B2
	(ii) $5a + b = 11$	B1	
	$(a+b)^2 + 4(a+b) = 21$	B1	
	$(11 - 5a + a)^2 + 4(11 - 5a + a) = 21$	M1	**OR** corresponding equation in b
	$(8)(2a^2 - 13a + 18) = (8)(2a - 9)(a - 2) = 0$	M1	**OR** $(8)(2b + 23)(b - 1) = 0$
	$a = \frac{9}{2}, 2$ OR $b = \left(-\frac{23}{2}\right), 1$	A1 A1 [6]	A1 for either a or b correct. Condone 2nd value. Spotted solution scores only B marks.
	Alt. **(ii)** Last 5 marks		**Alt. (ii)** Last 4 marks
	$f^{-1}(x) = \sqrt{x+4} - 2$ B1		$(a + b + 7)(a + b - 3) = 0$ M1A1
	$g(1) = f^{-1} = (21)$ used M1		(Ignore solution involving $a + b = -7$)
	$a + b = \sqrt{25} - 2 = 3$ A1		Solve $a + b = 3$, $5a + b = 11$ M1
	Solve $a + b = 3$, $5a + b = 11$ M1		$a = 2$, $b = 1$ A1
	$a = 2$, $b = 1$ A1		
11	**(i)** $\frac{dy}{dx} = \left[\frac{1}{2}(x4 + 4x + 4)^{-\frac{1}{2}}\right] \times \left[4x^3 + 4\right]$	B1B1	
	At $x = 0$, $\frac{dy}{dx} = \frac{1}{2} \times \frac{1}{2} \times 4 = (1)$	M1	Sub $x = 0$ and attempt eqn of line following differentiation.
	Equation is $y - 2 = x$	A1 [4]	
	(ii) $x + 2 = \sqrt{x^4 + 4x + 4} \Rightarrow (x+2)^2$	B1	**AG** www
	$= x4 + 4x + 4$		
	$x^2 - x^4 = 0$ oe	B1	
	$x = 0, \pm 1$	B2,1,0 [4]	
	(iii) $(\pi)\left[\frac{x^5}{5} + 2x^2 + 4x\right]$	M1A1	Attempt to integrate y^2
	$(\pi)\left[0 - \left(\frac{-1}{5} + 2 - 4\right)\right]$	DM1	
	$\frac{11\pi}{5}$ (6.91) oe	A1 [4]	Apply limits $-1 \rightarrow 0$