1 $k^3 \times \left(\frac{1}{3}x\right)^2 \times 10$ (or correct factorials) $10 \times k^3 \times \frac{1}{9} = 30 \Rightarrow k = 3$	B2 B1 [3]	B1 for 2/3 terms correct cao
2 **(i)** $5[8 + 9 \times 4]$ 220 **(ii)** $\frac{4\left(2^{10} - 1\right)}{2 - 1}$ 4092	M1 A1 [2] M1 A1 [2]	Use correct formula with a=4, d=4 Use correct formula with a=4, r=2 or ½ 4090 without 4092 A0
3 **(i)** $2x^5 + 3x^2 = 2x \Rightarrow 2x^5 + 3x^2 - 2x = 0$ $[x(2x]^4 + 3x^2 - 2) = 0$ $2x^4 + 3x^2 - 2 = 0$ **(ii)** $(x^2 + 2)(2x^2 - 1) = 0$ $x = \pm\ 1/\sqrt{2}$ only $\left(1/\sqrt{2},\ 2/\sqrt{2}\right), \left(-1/\sqrt{2},\ -2/\sqrt{2}\right)$	M1 A1 [2] M1 A1 A1 [3]	First line essential **AG** Factorising needed for A1 Reasonable attempt at solving a quadratic in x^2 For a correct pair of solutions, either 2 x's or 1 x and 1 y SC (±0.707, ±1.41) AWRT B1
4 **(i)** $10^2 \sin 0.8 = 71.7$ **(ii)** sector(s) = (2) × ½ × 10^2 × 0.8 = (2) × 40 Total area = 80 **(iii)** arc(s) = (2) × 10 × 0.8 16+20 = 36	M1A1 [2] M1 A1 [2] M1 A1 [2]	Completely correct method for a triangle Correct formula used for a sector Correct formula used for an arc
5 **(i)** $3\cos^2 x + 8\cos x + 4 = 0$ $(3\cos x + 2)(\cos x + 2) = 0$ $\cos x = -\frac{2}{3}$ **(ii)** $\cos(\theta + 70) = -\frac{2}{3}$, $\theta = 61.8$ $\theta + 70 = 131.8$ (or 228.2) $\theta = 158.2$	M1 M1 A1 [3] M1 A1 M1 A1 [4]	Use of $c^2 + s^2 = 1$ Factorising, formula or completing the square needed **AG** Ignore $\cos x = -2$ also offered SC B1 if –2/3 and –2 seen

6	**(i)** Scalar product = 15−8+3 10 = |**OA**| |**OB**| cos θ |**OA**| = √26, |**OB**| = √38 Angle *BOA* = 71.4 or 71.5 or 1.25 radians	M1 M1 M1 A1 [4]	Use of $x_1x_2 + y_1y_2 + z_1z_2$ Correct magnitude for either Linking everything correctly cao
	(ii) **a**+½(**b**–**a**) or **b**+½(**a**–**b**) or ½(**a**+**b**) –2**b** + *their* **c** oe –6**i** + **5**j + **4**k	M1 M1 A2,1,0 [4]	
7	**(i)** y = m(*x* – 2) oe	B1 [1]	Accept y = m*x* + c, c = – 2m
	(ii) $x^2 - 4x + 5 = mx - 2m \Rightarrow x^2 - x(4 + m) + 5 + 2m = 0$ $(4 + m)^2 - 4(5 + 2m) = 0 \Rightarrow m^2 - 4 = 0$ m = ±2 $m = 2 \Rightarrow x^2 - 6x + 9 = 0 \Rightarrow x = 3$ $m = -2 \Rightarrow x^2 - 2x + 1 = 0 \Rightarrow x = 1$ (3, 2), (1, 2)	M1 DM1 A1 DM1 A1 A1 [6]	 Apply $b^2 - 4ac$ Substitute their m and attempt to solve for x Allow for a pair of x values or 1 *x* and 1 y.
	OR m = 2*x* – 4 **$y = mx - 2m$, $y = x^2 - 4x + 5$**	M1 M1 M1 A1 A1 A1	**Eliminating 2 variables from 3 equations.** **Obtaining a quadratic in x or y.** **Solving their quadratic correctly.** A pair of x values or 1 *x* and 1 y.. m=2,–2 also needed for final mark.
	(iii) $(x - 2)^2 + 1$, (2, 1)	B1,B1 [2]	

8 **(i)** $f'(3) = 0 \Rightarrow 18 + 3k - 12 = 0$ $k = -2$ $(x - 3)(x + 2) = 0$ $x = -2$, (Allow also = 3)	M1 A1 M1 A1 [4]	 AG
(ii) $f''(x) = 4x - 2$ $f''(3) > 0$ hence min at P $f''(-2) < 0$ hence max at Q	 B1 B1 [2]	 3 min, –2 max independent of $f''(x)$
(iii) $f(x) = \frac{2}{3}x^3 - x^2 - 12x\ (+ c)$ Sub (3, –10) → $-10 = 18 - 9 - 36 + c$ $c = 17$	B2,1,0 M1 A1 [4]	Accept anywhere in question Dependent on c present Condone y =, or equation =
9 **(i)** $f^{-1}(x) = \frac{1}{2}x - \frac{3}{2}$ $2x + 3 = \frac{1}{2}x - \frac{3}{2} \Rightarrow x = -3$	B1 M1A1 [3]	
(ii) 2 lines approximately correct, reflected in $y=x$ & meeting at $(-3, -3)$	B3,2,1,0 [3]	Can be implied by graph or in writing. Ignore lines extended
(iii) $gf(x) = (2x + 3)^2 - 6(2x + 3)$ $4x^2 - 9$ $4x^2 - 9 \le 16 \Rightarrow x^2 \le \frac{25}{4}$ $-\frac{5}{2} \le x \le 0$	M1 A1 M1 A1A1 [5]	 Solving any quadratic to do with f and g ≤16, to x = Condone < and >

10 (i) $\int (x+1)^{\frac{1}{2}} - (x+1)$ or $\int (y^2-1)-(y-1)$	M1	Dealing with line as a triangle or integral with correct limits.
$\frac{2}{3}(x+1)^{\frac{3}{2}} - \frac{1}{2}x^2 - x$ or $\frac{1}{3}y^2 - \frac{1}{2}y^2$	M1A1	Attempt at integral of curve.
$\frac{2}{3} - \left(0 - \frac{1}{2} + 1\right)$ or $\frac{1}{3} - \frac{1}{2}$	DM1	Applying limits $-1 \to 0$ or $0 \to 1$ to curve
$\frac{1}{6}$	A1 [5]	π included loses last mark.
(ii) $V_1 = (\pi)\int (y^2-1)^2 = (\pi)\int y^4 - 2y^2 + 1$	M1	Attempt at $\int x^2$ dy for curve
$(\pi)\left[\frac{y^5}{5} - \frac{2y^2}{3} + y\right]$	A1	
$(\pi)\left[\frac{1}{5} - \frac{2}{3} + 1\right]$	DM1	Apply limits $0 \to 1$
$V_1 = \frac{8}{15(\pi)}$ or 0.533(π) (AWRT)	A1	
or $(\pi)\left[\frac{y^3}{3} - y^2 + y\right]$	M1	Or $\frac{1}{3} \times \pi(\times 1^2 \times 1)$
$V_2 = \frac{1}{3}\pi$	A1	Vol of cone or attempt to $\int x^2 dy$ for line
Volume $= \frac{8}{15}\pi \quad \frac{1}{-3}\pi = \frac{1}{5}\pi$ (or 0.628)	A1 [7]	
OR $(y^4 - 2y^2 + 1) - (y^2 - 2y + 1)$	M1	Attempt to $\int x^2 dy$
$(\pi)\int y^4 - 3y^2 + 2y$	M1	Attempt to $\int (x_1^2 - x_2^2)$
$(\pi)\left[y\uparrow 5/5 - y\uparrow 3 + y\uparrow 2\right]$	A1,A1,A1	
$(\pi)\left[\frac{1}{5} - 1 + 1\right]$	DM1	Apply limits $0 \to 1$ dependent on first M1
$\frac{1}{5}\pi$	A1	

$\int_{-1}^{0} x+1-\int_{-1}^{0}(x+1))^2$	M1	SC MR integrating about x axis
$\left[\frac{x^2}{2}+x\right]-\left[\frac{x+1^3}{3}\right]$		
SC $=\left[(0)-\left(\frac{1}{2}-1\right)\right]-\left[\frac{1}{3}-0\right]$	M1	Use of $-1,0$ as limits
$\frac{1}{2}-\frac{1}{3}=\frac{1}{6}\pi$ (0.524)	A1	