1 Vol = (π) $\int x^2 dy = (\pi) \int (y-1)\, dy$	M1 A1	Use of $\int x^2$ – not $\int y^2$ – ignore π co
Integral is $\frac{1}{2}y^2 - y$ or $\frac{(y-1)^2}{2}$		
Limits for y are 1 to 5	B1	Sight of an integral sign with 1 and 5
$\to 8\pi$ or 25.1(AWRT)	A1 [4]	co (no π max 3/4)
2 **(i)** $\tan\theta = \frac{5}{12}$ $\to$ ($\theta = 0.3948$)	M1 [1]	Any valid trig method ag
(ii) Other angle in triangle = $\frac{1}{2}\pi - 0.3948$	B1	Unsimplified OK
Area of triangle $AOB = \frac{1}{2} \times 12 \times 5$ (= 30)	B1	co
Use of $\frac{1}{2}r^2\theta$ once	M1	With θ in radians and $r = 5$ or 12
Shaded area = sector + sector – triangle $= \frac{1}{2} \times 12^2 \times 0.3948 + \frac{1}{2}5^2\theta - 30$	DM1	Sum of 2 sectors – triangle or any other valid method using the given angle and a different one.
$= 28.43 + 14.70 - 30 = 13.1$	A1 [5]	co
3 **(i)** $(1+x)^5 = 1 + 5x + 10x^2$	B2,1 [2]	Loses 1 for each error
(ii) $(1 + px + x^2)^5$ $(1+)\ 5(px + x^2) + 10(px + x^2)^2$	M1	Replace x by $(px + x^2)$ in their expansion
Coeff of $x^2 = 5 + 10p^2$ $= 95 \to p = 3$	DM1 A1 [3]	Considers 2 terms co – no penalty for ±3
4 $y = \frac{12}{3-2x}$		
(i) Differential $= -12(3-2x)^{-2} \times -2$	B1 B1 [2]	co co (even if 1st B mark lost)
(ii) $\frac{dy}{dx} = \frac{dy}{dt} \div \frac{dx}{dt} = 0.4 \div 0.15$	M1	Chain rule used correctly (AEF)
$\to \frac{24}{(3-2x)^2} = \frac{8}{3}$	M1	Equates their $\frac{dy}{dx}$ with their $\frac{8}{3}$ or $\frac{3}{8}$
$\to x = 0$ or 3	A1 A1 [4]	co co

5 $1 + \sin x \tan x = 5\cos x$		
(i) Replaces t by s/c	M1	Correct formula
$1 + \dfrac{s^2}{c} = 5c$		
Replace s^2 by $1 - c^2$	M1	Correct formula used in appropriate place
$\rightarrow\ 6c^2 - c - 1\ (= 0)$	A1 [3]	AG
(ii) Soln of quadratic $\rightarrow$ ($c = -\frac{1}{3}$ or $\frac{1}{2}$) $\rightarrow\ x = 60°$ or $109.5°$	M1 A1 A1 [3]	Correct method co co
6 $y = x^3 + ax^2 + bx$		
(i) $\dfrac{dy}{dx} = 3x^2 + 2ax + b$	B1	co
(ii) $b^2 - 4ac = 4a^2 - 12b\ (< 0)$	M1	Use of discriminant on their quadratic $\dfrac{dy}{dx}$ or other valid method
$\rightarrow\ a^2 < 3b$	A1 [3]	co – answer given
(iii) $y = x^3 - 6x^2 + 9x$		
$\dfrac{dy}{dx} = 3x^2 - 12x + 9 < 0$	M1	Attempt at differentiation
$= 0$ when $x = 1$ and 3	A1	co
$\rightarrow\ 1 < x < 3$	A1 [3]	condone $\leqslant$
7 (i) $\mathbf{AM} = -6\mathbf{i} + 2\mathbf{j} + 5\mathbf{k}$ $\mathbf{AC} = -8\mathbf{i} + 8\mathbf{j}$	B2,1 B1 [3]	co −1 each error co
(ii) $\mathbf{AM}.\mathbf{AC} = 48 + 16 = 64$	M1	Use of x_1y_1 + etc. with suitable vectors
$64 = \sqrt{128}\sqrt{65}\cos\theta$ $\rightarrow\ \theta = 45.4°$	M1 M1 A1 [4]	Product of moduli. Correct link. co

8 **(a)** $S_n = 32n - n^2$. Set n to 1, a or $S_1 = 31$ Set n to 2 or other value $S_2 = 60$ $\rightarrow$ 2nd term = 29 $\rightarrow$ $d = -2$ (or equates formulae – compares coeffs n^2, n) [M1 comparing, A1 d A1 a]	 B1 M1 A1 [3]	 co Correct method. co [M1 only when coeffs compared]
(b) $\frac{a}{1-r} = 20$, $\frac{a(1-r)^2}{1-r}$, or $a + ar = 12.8$	B1 B1	co co
Elimination of $\frac{a}{1-r}$ or a or r	M1	'Correct' elimination to form equation in a or r
$\rightarrow$ $(r = 0.6)$ $\rightarrow$ $a = 8$	DM1 A1 [5]	Complete method leading to $a =$ Condone $a = 8$ and 32
9 **(i)** $m_{AB} = -3$ or $\frac{-9}{3}$	B1	oe
$m_{AD} = \frac{1}{3}$	M1	use of $m_1 m_2 = -1$ with grad AB
Eqn AD $y - 6 = \frac{1}{3}(x - 2)$ or $3y = x + 16$	A1 [3]	co – OK unsimplified
(ii) Eqn CD $y - 3 = -3(x - 8)$ or $y = -3x + 27$ Sim Eqns $\rightarrow$ D (6½, 7½)	B1√ M1 A1 [3]	OK unsimplified. √on m of AB. Reasonable algebra leading to $x =$ or $y =$ with AD and CD
(iii) Use of vectors or mid-point $\rightarrow$ E (5, 12) or mid-point (5,4.5) Length of $BE = 15$	 B1 B1 [2]	 May be implied co
10 $\frac{d^2y}{dx^2} = \frac{24}{x^3} - 4$ **(i)** (If $x = 2$) it's negative $\rightarrow$ Max	 B1 [1]	 www
(ii) $\left(\frac{dy}{dx} =\right) -12x^{-2} - 4x + (A)$ $= 0$ when $x = 2$ $\rightarrow$ $A = 11$	B2,1,0 M1 A1 [4]	oe one per term Attempt at the constant A after ∫n co
(iii) $(y =)$ $12x^{-1} - 2x^2 + Ax + (c)$ $y = 13$ when $x = 1$ $\rightarrow$ $c = -8$ (If $x = 2$) $y = 12$	B2,1,0 √ M1 A1 [4]	oe Doesn't need $+c$, but does need a term A to give "Ax". Attempt at c after ∫n co

11 $f : x \mapsto 6 - 4\cos\left(\frac{1}{2}x\right)$		
(i) $6 - 4\cos\left(\frac{1}{2}x\right) = 4 \to 4\cos\left(\frac{1}{2}x\right) = 2$	M1	Makes $\cos\left(\frac{1}{2}x\right)$ the subject.
$\frac{1}{2}x = \frac{1}{3}\pi \quad x = \frac{2}{3}\pi$	M1	Looks up "$\frac{1}{2}x$" before ×2
	A1 [3]	co (120° gets A0 – decimals A0)
(ii) Range is $2 \leqslant f(x) \leqslant 10$	B1 B1 [2]	condone <
(iii)	B1 B1 [2]	Point of inflexion at π Fully correct
(iv) $\cos\left(\frac{1}{2}x\right) = \frac{1}{4}(6 - y)$	M1	Makes $\cos\left(\frac{1}{2}x\right)$ the subject
$\frac{1}{2}x = \cos^{-1}\left(\frac{1}{4}(6 - y)\right)$	M1	Order of operations correct (M marks allowed if + for –)
$f^{-1}(x) = 2\cos^{-1}\left(\frac{6 - x}{4}\right)$	A1 [3]	oe – needs to be a function of x not y