1 $\tan x = k$		
(i) $\tan(\pi - x) = -k$	B1 [1]	co. www Mark final answers
(ii) $\tan\left(\frac{\pi}{2} - x\right) = \frac{1}{k}$	B1 [1]	co. www
(iii) $\sin x = \frac{k}{\sqrt{1+k^2}}$ from 90° triangle.	M1 A1 [2]	Any valid method – 90° triangle or formulae.
2 $\left(2x - \frac{3}{x}\right)^5$		
(i) $32x^5 - 240x^3 + 720x$	3 × B1 [3]	co. SC B2 for other 3 terms (i.e. ascending)
(ii) $\left(1 + \frac{2}{x^2}\right)(32x^5 - 240x^3 + 720x)$		
Coeff of x (1 × 720) + (2 × –240) → 240	M1 A1√ [2]	Looks at exactly 2 terms. co from his answer to **(i)**.
3 9th term = 22, $S_4 = 49$		
(i) $a + 8d = 22$	B1	co
$2(2a + 3d) = 49$	B1	co
Soln of sim eqns → $d = 1.5$, $a = 10$	M1 A1 [4]	Solution of two linear sim eqns. co
(ii) $a + (n-1)d = 46$ Substitutes for a and d → $n = 25$	M1 A1 [2]	Correct formula needed and attempt to solve. co.
4 $y = 6x - x^2$		
Meets $y = 5$ when $x = 1$ or $x = 5$.	B1	co
Integral = $3x^2 - \frac{1}{3}x^3$	M1 A1	attempt to integrate. co.
Their limits (1 to 5) used → 30⅔	DM1	value at top limit – value at lower
Area of rectangle = 20	B1√	co to his x values
Shaded area = 10⅔	A1 [6]	co
(integral of $6x - x^2 - 5$ B1, M1, A1 DM1 as above, then "$-5x$" B1√ A1)		

5 $x \mapsto 2\sin^2 x - 3\cos^2 x$		
(i) $2(1-\cos^2 x) - 3\cos^2 x$	M1	Uses $s^2 + c^2 = 1$
$\rightarrow$ $2 - 5\cos^2 x$ $(a = 2, b = -5)$	A1 [2]	co
(ii) Values are −3 and 2	B1√ B1√ [2]	
(iii) $2 - 5\cos^2 x = -1$		
$\rightarrow$ $\cos^2 x = 0.6$	B1√	
x = 0.685, 2.46 (accept 0.684)	B1 B1√ [3]	co √ for $\pi -$ (first answer) SC B1 for both 39.2 and 140.8
6 $\frac{dy}{dx} = 3\sqrt{x} - 6$ (9, 2)		
(i) $y = \frac{3x^{\frac{3}{2}}}{\frac{3}{2}} - 6x\,(+c)$	B2,1	Loses 1 for each error – ignore $+c$
(9, 2) $2 = 54 - 54 + c$	M1	Uses (9, 2) with integration to find c.
$\rightarrow$ $c = 2$.	A1 [4]	co.
(ii) $\frac{dy}{dx} = 0 \rightarrow x = 4$	B1	Ignore any y-value
$\frac{d^2y}{d^2x} = \frac{3x^{-\frac{1}{2}}}{2}$	M1 A1	Any valid method. co.
$\rightarrow$ +ve (or ¾) Minimum	[3]	
7 $y = 2 - \frac{18}{2x+3}$		
(i) A is (3, 0)	B1	Anywhere – but not from given answer
$\frac{dy}{dx} = 18(2x+3)^{-2} \times 2$	B1 B1	B1 for $18(2x+3)^{-2}$, B1 for ×2
If $x = 3$, $m = \frac{4}{9}$.		
m of normal = $-\frac{9}{4}$	M1	Use of $m_1 m_2 = -1$ with m from dy/dx
Equation of normal $y = -\frac{9}{4}(x-3)$	M1	Correct method for normal
$\rightarrow$ $4y + 9x = 27$	A1 [6]	co (answer was given)
(ii) Normal meets y-axis at (0, 6¾)		
Curve meets y-axis at (0, −4)	M1	Needs to put $x = 0$ in both normal and curve. co
$\rightarrow$ BC = 10¾	A1 [2]	

8 **(i)** y-step ÷ x-step = 2 → $m = 1$	M1 A1 [2]	Gradient = y-step ÷ x step used co
(ii) Eqn of AC $y + 2 = -2(x - 3)$ Eqn of BC $y - 22 = (x - 15)$ Sim eqns $y + 2x = 4$, $y = x + 7$ → $C\,(-1, 6)$	M1 A1√ A1√ A1 [4]	Correct form of one of lines. √ to his m √ to his m co
(iii) M is (9, 10) Perp gradient is $-\frac{1}{2}$ → $2y + x = 29$, $y = x + 7$ Sim eqns → $D\,(5, 12)$	B1 M1 M1 A1 [4]	co Use of $m_1 m_2 = -1$ Solve sim eqns for their BC & perp. bis co
9 **(i)** $2x^2 - 12x + 7 = 2(x - 3)^2 - 11$	3 × B1 [3]	B1 for each value – accept if a, b, c not specifically quoted.
(ii) Range of f $\geqslant -11$	B1√ [1]	√ to his "c". allow > or ⩾.
(iii) $2x^2 - 12x + 7 < 21$ → $2x^2 - 12x - 14$ or $2(x - 3)^2 < 32$ → end-values of 7 or −1 → $-1 < x < 7$	 M1 A1 A1 [3]	 3-term quadratic to 0 or $2(x-3)^2 < 32$ Correct end-values co
(iv) $gf(x) = 2(2x^2 - 12x + 7) + k = 0$ Use of $b^2 - 4ac$ → $24^2 - 16(14 + k)$ → $k = 22$	M1 A1 M1 A1 [4]	Puts f into g. co. Used correctly with quadratic co.
10 $\overrightarrow{OA} = \mathbf{i} + 3\mathbf{j} + 3\mathbf{k}$, $\overrightarrow{OC} = 3\mathbf{i} - \mathbf{j} + \mathbf{k}$.		
(i) $\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{OC} = 4\mathbf{i} + 2\mathbf{j} + 4\mathbf{k}$ Unit vector = $\frac{1}{6}(4\mathbf{i} + 2\mathbf{j} + 4\mathbf{k})$	B1 M1 A1√ [3]	co Divides by the modulus. √ on $\overrightarrow{OB}$.
(ii) $\overrightarrow{AC} = \overrightarrow{OC} - \overrightarrow{OA} = 2\mathbf{i} - 4\mathbf{j} - 2\mathbf{k}$ $\overrightarrow{AC}.\overrightarrow{OB} = 8 - 8 - 8 = -8$ $\lvert\overrightarrow{OB}\rvert = 6$; $\lvert\overrightarrow{AC}\rvert = \sqrt{24}$ $-8 = 6 \times \sqrt{24} \times \cos\theta$ $\theta = 105.8° \rightarrow 74.2°$	B1 M1 M1 M1 A1 [5]	co Use of $x_1 x_2 + y_1 y_2 + z_1 z_2$ Correct method for a modulus. Connected correctly provided $\overrightarrow{OB}$, $\overrightarrow{AC}$ used co (accept acute or obtuse)
(iii) $OA = \sqrt{19}$ or $OC = \sqrt{11}$ Perimeter = 2(√ + √) → 15.4	B1 M1 A1 [3]	Used as a length. co (accept 15.3)