1 $\frac{dy}{dx}=\frac{6}{x^2}$ $y=-6x^{-1}+c$ Uses (2, 9) → $c = 12$ $y=-6x^{-1}+12$	B1 M1 A1 [3]	Integration only – unsimplified Uses (2, 9) in an integral
2 $\left(2x-\frac{1}{2x}\right)^6$ **(i)** Coeff of $x^2 = 15\times16\times(-½)^2 = 60$ **(ii)** Constant term is $20\times8x^3\times(-1\div8x^3)$ $\times(1+x^2)$ needs to consider 2 terms → $60-20=40$	B1 B1 [2] B1 M1 A1 [3]	B1 for 2/3 parts. B1 B1 unsimplified Needs to consider the constant term
3 $mx+14=\frac{12}{x}+2 \rightarrow mx^2+12x-12=0$ Uses $b^2=4ac \rightarrow m=-3$ $-3x^2+12x-12=0 \rightarrow P\,(2, 8)$ [Or $m=-12x^{-2}$ M1 Sub M1 $x = 2$ A1] [→ $m = -3$ and $y = 8$ M1 A1]	M1 M1 A1 DM1 A1 [5]	Eliminates x (or y) Any use of discriminant Any valid method.
4 **(i)** $BOC = 2\tan^{-1}½ = 0.9273$ **(ii)** $OB = \sqrt{(10^2+5^2)}$ or $11.2 = r$ Arc $BXC = \sqrt{125}\times0.9273$ → Perimeter = 20.4 cm **(iii)** Area = $½r^2\theta$ − ½.10.10 → 7.96 cm².	M1 A1 [2] B1 M1 A1 [3] M1 A1 [2]	Correct trigonometry. (ans given) Use of trig (or Pyth) for the $OB = \sqrt{125}$. Use of $s = r\theta$ with θ in rads , $r \neq 10$ Correct formula used with rads, $r \neq 10$. Allow 7.95 or 7.96
5 $a=\sin\theta-3\cos\theta,\ b=3\sin\theta+\cos\theta$ **(i)** $a^2+b^2=$ $(s^2+9c^2-6sc)+(9s^2+c^2+6sc)$ $10c^2+10s^2=10$ **(ii)** $2s-6c=3s+c \rightarrow s=-7c$ → $\tan\theta=-7$ → 98.1° and 278.1°	B1 M1 A1 [3] M1 A1 A1 A1√ [4]	Correct squaring Use of $s^2 + c^2 = 1$ to get constant. (can get 2/3 for missing $6sc$) Collecting and t = s÷c For 180^0 + first answer, providing no extra answers in the range.

6 $\overrightarrow{OA} = \mathbf{i} - 2\mathbf{j} + 2\mathbf{k}$, $\overrightarrow{OB} = 3\mathbf{i} + p\mathbf{j} + q\mathbf{k}$ **(i)** $p = -6, q = 6$ **(ii)** dot product = 0 → $3 - 2p + 4p = 0$ → $p = -1.5$ **(iii)** $\overrightarrow{AB}$ = b − a = **2**i + **3**j + 6**k** Unit vector = (**2**i + **3**j + 6**k**) ÷ **7**	B1 B1 [2] M1 A1 [2] B1 M1 A1√ [3]	 Use of $x_1x_2 + y_1y_2 + z_1z_2 = 0$ not for **b** – **a**. M1 for division by modulus. √ on B1.
7 $3y + 2x = 33$. Gradient of line = −⅔ Gradient of perpendicular = 3/2 Eqn of perp $y - 3 = \frac{3}{2}(x+1)$ Sim Eqns → (3, 9) (−1, 3) → (3, 9) → (7, 15)	 B1 M1 M1 M1 A1 M1 A1 [7]	 Use of $m_1m_2 = -1$ with gradient of line Correct form of perpendicular eqn. Sim eqns. Vectors or other method.
8 **(i)** $\pi r^2 h = 250\pi \rightarrow h = \frac{250}{r^2}$ $\rightarrow S = 2\pi rh + 2\pi r^2$ $\rightarrow S = 2\pi r^2 + \frac{500\pi}{r}$ **(ii)** $\frac{dS}{dr} = 4\pi r - \frac{500\pi}{r^2}$ = 0 when $r^3 = 125$ → $r = 5$ → $S = 150\pi$ **(iii)** $\frac{d^2S}{dr^2} = 4\pi + \frac{1000\pi}{r^3}$ This is positive → Minimum	 M1 M1 [2] B1 B1 M1 A1 [4] M1 A1 [2]	 Makes h the subject. $\pi r^2 h$ must be right Ans given – check all formulae.. B1 for each term Sets differential to 0 + attempt at soln Any valid method. 2nd differential must be correct – no need for numerical answer or correct r.
9 $f(x) = \frac{5}{1-3x}$, $x \geq 1$ **(i)** $f'(x) = \frac{-5}{(1-3x)^2} \times -3$ **(ii)** $15 > 0$ and $(1-3x)^2 > 0$, $f'(x) > 0$ → increasing **(iii)** $y = \frac{5}{1-3x} \rightarrow 3x = 1 - \frac{5}{y}$ $\rightarrow f^{-1}(x) = \frac{x-5}{3x}$ or $⅓ - \frac{5}{3x}$ Range is ≥ 1 Domain is $-2.5 \leq x < 0$	 B1 B1 [2] B1√ [1] M1 A1 B1 B1 B1 [5]	 B1 without × −3. B1 for ×−3, even if first B mark is incorrect √ providing ( )² in denominator. Attempt to make x the subject. Must be in terms of x. must be ≥ condone <

10 **(a)** $57 = 2(24 + 3d) \rightarrow d = 1.5$ $48 = 12 + (n - 1)1.5 \rightarrow n = 25$	M1 A1 M1 A1 [4]	Use of correct S_n formula. Use of correct T_n formula.
(b) $ar^2 = 4a \quad r = \pm 2$ $\frac{a(r^6 - 1)}{r - 1} = ka$ $\rightarrow k = 63$ or $k = -21$	B1 B1 B1 B1 [4]	(allow for $r = 2$)
11 $y = \sqrt{1 + 4x}$ **(i)** $\frac{dy}{dx} = \frac{1}{2}(1 + 4x)^{-\frac{1}{2}} \times 4$ $= 2$ at B (0, 1) Gradient of normal $= -½$ Equation $y - 1 = -½ x$	B1 B1 M1 M1 A1 [5]	B1 Without "×4". B1 for "×4" even if first B mark lost. Use of $m_1m_2 = -1$ Correct method for eqn.
(ii) At A $x = -¼$ $\int \sqrt{1 + 4x}\,dx = \frac{(1 + 4x)^{\frac{3}{2}}}{\frac{3}{2}} \div 4$ Limits $-¼$ to 0 $\rightarrow \frac{1}{6}$ Area $BOC = ½ \times 2 \times 1 = 1$ $\rightarrow$ Shaded area $= \frac{7}{6}$	B1 B1 B1 B1 B1√ [5]	B1 Without the "÷4". For "÷4" even if first B mark lost. For 1 + his "1/6".