C2

1.

1	2·236067977		
1·25	2·439902662		
1·5	2·715695123		
1·75	3·059309563	(5 values correct)	B2
2	3·464101615	(3 or 4 values correct)	B1

Correct formula with $h = 0{\cdot}25$ M1

$$I \approx \frac{0{\cdot}25}{2} \times \{2{\cdot}236067977 + 3{\cdot}464101615 + 2(2{\cdot}439902662 + 2{\cdot}715695123 + 3{\cdot}059309563)\}$$

$I \approx 22{\cdot}12998429 \times 0{\cdot}25 \div 2$

$I \approx 2{\cdot}766248036$

$I \approx 2{\cdot}766$ (f.t. one slip) A1

Special case for candidates who put $h = 0{\cdot}2$

1	2·236067977		
1·2	2·393324048		
1·4	2·596921254		
1·6	2·845347079		
1·8	3·135602016		
2	3·464101615	(all values correct)	B1

Correct formula with $h = 0{\cdot}2$ M1

$$I \approx \frac{0{\cdot}2}{2} \times\{2{\cdot}236067977 + 3{\cdot}464101615 + 2(2{\cdot}393324048 + 2{\cdot}596921254 + 2{\cdot}845347079 + 3{\cdot}135602016)\}$$

$I \approx 27{\cdot}64255839 \times 0{\cdot}2 \div 2$

$I \approx 2{\cdot}764255839$

$I \approx 2{\cdot}764$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

2. (*a*) $7\sin^2\theta + 1 = 3(1 - \sin^2\theta) - \sin^2\theta$

(correct use of $\cos^2\theta = 1 - \sin^2\theta$) M1

An attempt to collect terms, form and solve quadratic equation in $\sin\theta$, either by using the quadratic formula or by getting the expression into the form $(a\sin\theta + b)(c\sin\theta + d)$, with $a \times c$ = coefficient of $\sin^2\theta$ and $b \times d$ = candidate's constant m1

$10\sin^2\theta + \sin\theta - 2 = 0 \Rightarrow (2\sin\theta + 1)(5\sin\theta - 2) = 0$

$\Rightarrow \sin\theta = -\frac{1}{2},\ \sin\theta = \frac{2}{5}$ (c.a.o.) A1

$\theta = 210°, 330°$ B1 B1

$\theta = 23{\cdot}58°, 156{\cdot}42°$ B1

Note: Subtract 1 mark for each additional root in range for each branch, ignore roots outside range.
$\sin\theta$ = +, –, f.t. for 3 marks, $\sin\theta$ = –, –, f.t. for 2 marks
$\sin\theta$ = +, +, f.t. for 1 mark

(*b*) $2x + 25° = 117°, 243°$, (one value) B1

$x = 46°, 109°$ B1, B1

Note: Subtract (from final two marks) 1 mark for each additional root in range, ignore roots outside range.

3. (*a*) $(x + 6)^2 = x^2 + (x + 1)^2 - 2 \times x \times (x + 1) \times \cos 120°$

(correct use of cos rule) M1

$2x^2 - 9x - 35 = 0$ (convincing) A1

An attempt to solve quadratic equation in x, either by using the quadratic formula or by getting the expression into the form $(ax + b)(cx + d)$, with $a \times c = 2$ and $b \times d = -35$ M1

$(2x + 5)(x - 7) = 0 \Rightarrow x = 7$ A1

(*b*) Area $= \frac{1}{2} \times 7 \times (7 + 1) \times \sin 120°$

(substituting the correct values in the correct places in the area formula, f.t. candidate's derived value for x) M1

Area $= 24{\cdot}25\ \text{cm}^2$ (f.t. candidate's derived value for x) A1

4. (*a*) $S_n = a + [a + d] + \ldots + [a + (n - 1)d]$

(at least 3 terms, one at each end) B1

$S_n = [a + (n - 1)d] + [a + (n - 2)d] + \ldots + a$

Either:

$2S_n = [a + a + (n - 1)d] + [a + a + (n - 1)d] + \ldots + [a + a + (n - 1)d]$

Or:

$2S_n = [a + a + (n - 1)d] + \ldots$ (n times) M1

$2S_n = n[2a + (n - 1)d]$

$S_n = \frac{n}{2}[2a + (n - 1)d]$ (convincing) A1

(*b*) $a + 7d = 28$ B1

$\frac{20}{2} \times [2a + 19d] = 710$ B1

An attempt to solve the candidate's equations simultaneously by eliminating one unknown M1

$d = 3$ (c.a.o.) A1

$a = 7$ (f.t. candidate's value for d) A1

(*c*) $S_{15} = \frac{15}{2} \times (-3 + 67)$

(substitution of values in formula for sum of A.P.) M1

$S_{15} = 480$ A1

5. (*a*) (i) $ar = 6$ and $ar^4 = 384$ B1

$r^3 = \frac{384}{6}$ (o.e.) M1

$r = 4$ (c.a.o.) A1

(ii) $a \times 4 = 6 \Rightarrow a = 1{\cdot}5$ B1

$S_8 = \frac{1{\cdot}5(4^8 - 1)}{4 - 1}$ (correct use of formula for S_8, f.t. candidate's derived values for r and a) M1

$S_8 = 32767{\cdot}5$ (f.t. candidate's derived values for r and a) A1

(*b*) (i) $5 \times 1{\cdot}1^{n-1} = 170$ M1

$1{\cdot}1^{n-1} = 34$ A1

$(n - 1)\log 1{\cdot}1 = \log 34$

(f.t. only $5{\cdot}5^{n-1} = 170$ or $1{\cdot}1^n = 34$) M1

$n = 38$ (c.a.o.) A1

(ii) $|r|$ must be < 1 for sum to infinity to exist E1

6. (*a*) $3 \times \frac{x^{1/2}}{1/2} - 4 \times \frac{x^{5/3}}{5/3} + c$ B1, B1

(–1 if no constant term present)

(*b*) (i) $25 - x^2 = -2x + 17$ M1

An attempt to rewrite and solve quadratic equation in x, either by using the quadratic formula or by getting the expression into the form $(x + a)(x + b)$, with $a \times b$ = candidate's constant m1

$(x - 4)(x + 2) = 0 \Rightarrow x = 4, -2$ (both values, c.a.o.) A1

$y = 9, y = 21$ (both values, f.t. candidate's x-values) A1

(ii) **Either:**

Total area $= \int_{-2}^{4}(25 - x^2)\,dx - \int_{-2}^{4}(-2x + 17)\,dx$

(use of integration) M1

(subtraction of integrals with correct use of candidate's x_A, x_B as limits) m1

$\int x^2\,dx = \frac{x^3}{3}$, $\int 2x\,dx = x^2$ B1 B1

Either: $\int 25\,dx = 25x$ **and** $\int 17\,dx = 17x$ or: $\int 8\,dx = 8x$ B1

Total area $= [25x - (1/3)x^3]_{-2}^{4} - [-x^2 + 17x]_{-2}^{4}$ (o.e.)

$= \{(100 - 64/3) - (-50 - (-8/3)\} - \{(-16 + 68) - (-4 - 34)\}$

(substitution of candidate's limits in at least one integral) m1

$= 36$ (c.a.o.) A1

Or:

Area of trapezium = 90

(f.t. candidate's x-coordinates for A, B) B1

Area under curve $= \int_{-2}^{4}(25 - x^2)\,dx$ (use of integration) M1

$= [25x - (1/3)x^3]_{-2}^{4}$

(correct integration) B2

$= \{(100 - 64/3) - (-50 - (-8/3)\}$

(substitution of candidate's limits) m1

$= 126$

Use of candidate's, x_A, x_B as limits and trying to find total area by subtracting area of trapezium from area under curve m1

Total area = 126 – 90 = 36 (c.a.o.) A1

7. $\log_a(6x^2 + 11) - \log_a x = \log_a\left(\frac{6x^2 + 11}{x}\right)$ (subtraction law) B1

$2\log_a 5 = \log_a 5^2$ (power law) B1

$\frac{6x^2 + 11}{x} = 5^2$ (removing logs) M1

An attempt to solve quadratic equation in x, either by using the quadratic formula or by getting the expression into the form $(ax + b)(cx + d)$, with $a \times c = 6$ and $b \times d = 11$ m1

$(2x - 1)(3x - 11) = 0 \Rightarrow x = {}^1/_2, {}^{11}/_3$ (both values, c.a.o.) A1

Note: Answer only with no working earns 0 marks

8. (*a*) (i) $A(1, -3)$ B1

(ii) Gradient $AP = \frac{\text{inc in } y}{\text{inc in } x}$ M1

Gradient $AP = \frac{(-7) - (-3)}{4 - 1} = -\frac{4}{3}$

(f.t. candidate's coordinates for A) A1

Use of $m_{\text{tan}} \times m_{\text{rad}} = -1$ M1

Equation of tangent is:

$y - (-7) = \frac{3}{4}(x - 4)$ (f.t. candidate's gradient for AP) A1

(*b*) An attempt to substitute $(x + 4)$ for y in the equation of the circle and form quadratic in x M1

$x^2 + (x + 4)^2 - 2x + 6(x + 4) - 15 = 0 \Rightarrow 2x^2 + 12x + 25 = 0$ A1

An attempt to calculate value of discriminant m1

Discriminant $= 144 - 200 < 0 \Rightarrow$ no points of intersection

(f.t. one slip) A1

9. (*a*) $4\theta = 5{\cdot}2$ M1

$\theta = 1{\cdot}3$ A1

(*b*) $RP = 4 \times \tan 1{\cdot}3$ cm (o.e.) (f.t. candidate's value for θ) B1

Area of triangle $POR = \frac{1}{2} \times 4 \times 4 \times \tan 1{\cdot}3\text{ cm}^2$ (o.e.)

(f.t. candidate's value for θ) M1

Area of sector $POQ = \frac{1}{2} \times 4 \times 4 \times 1{\cdot}3\text{ cm}^2$

(f.t. candidate's value for θ) M1

Either: Area of triangle $POR = 28{\cdot}8\text{ cm}^2$

Or: Area of sector $POQ = 10{\cdot}4\text{ cm}^2$

(f.t. candidate's value for θ) A1

An attempt to find shaded area by subtracting the derived area of the sector from the derived area of the triangle M1

Shaded area $= 28{\cdot}8 - 10{\cdot}4 = 18{\cdot}4\text{ cm}^2$ (c.a.o.) A1