1.

1	0·1111111111		
1·5	0·1709352011		
2	0·2329431339		
2·5	0·2969522777		
3	0·3628469322	(5 values correct)	B2

(**If B2 not awarded**, award B1 for either 3 or 4 values correct)

Correct formula with $h = 0{\cdot}5$ M1

$$I \approx \frac{0{\cdot}5}{2} \times \{0{\cdot}1111111111 + 0{\cdot}3628469322 + 2(0{\cdot}1709352011 + 0{\cdot}2329431339 + 0{\cdot}2969522777)\}$$

$I \approx 1{\cdot}875619269 \times 0{\cdot}5 \div 2$

$I \approx 0{\cdot}4689048172$

$I \approx 0{\cdot}4689$ (f.t. one slip) A1

Special case for candidates who put $h = 0{\cdot}4$

1	0·1111111111		
1·4	0·1587880562		
1·8	0·2078915826		
2·2	0·2583141854		
2·6	0·3099833063		
3	0·3628469322	(all values correct)	B1

Correct formula with $h = 0{\cdot}4$ M1

$$I \approx \frac{0{\cdot}4}{2} \times \{0{\cdot}1111111111 + 0{\cdot}3628469322 + 2(0{\cdot}1587880562 + 0{\cdot}2078915826 + 0{\cdot}2583141854 + 0{\cdot}3099833063)\}$$

$I \approx 2{\cdot}343912304 \times 0{\cdot}4 \div 2$

$I \approx 0{\cdot}4687824609$

$I \approx 0{\cdot}4688$ (f.t. one slip) A1

Note: Answer only with no working shown earns 0 marks

2. (*a*) $4(1 - \sin^2\theta) - 2\sin^2\theta - \sin\theta + 8 = 0$,

(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 $a \times c$ = candidate's coefficient of $\sin^2\theta$ and $b \times d$ = candidate's constant m1

$6\sin^2\theta + \sin\theta - 12 = 0 \Rightarrow (2\sin\theta + 3)(3\sin\theta - 4) = 0$

$\Rightarrow \sin\theta = -\frac{3}{2}$, $\sin\theta = \frac{4}{3}$ (c.a.o.) A1

$-1 \leq \sin\theta \leq 1 \Rightarrow$ no such θ can exist

(f.t. only if candidate has 2 real values for $\sin\theta$, **neither** of which satisfies $-1 \leq \sin\theta \leq 1$) E1

(*b*) $2x - 75° = -31°, 211°, 329°,$ (one value) B1

$x = 22°, 143°$ B1 B1

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

(*c*) $4\sin\phi + 7\sin\phi\cos\phi = 0$ **or** $4\tan\phi + 7\tan\phi\cos\phi = 0$

or $\sin\phi\left(\frac{4}{\cos\phi} + 7\right) = 0$ M1

$\sin\phi = 0$ (or $\tan\phi = 0$), $\cos\phi = -\frac{4}{7}$ (both values) A1

$\phi = 0°, 180°$ (both values) A1

$\phi = 124{\cdot}85°$ (c.a.o.) A1

Note: Subtract a maximum of 1 mark for each additional root in range for each branch, ignore roots outside range.

Special Case:

No factorisation but division throughout by $\sin\phi$ (or $\tan\phi$) to yield

$4 + 7\cos\phi = 0$ (or equivalent) M1

$\phi = 124{\cdot}85°$ A1

3. (*a*) $\frac{\sin ACB}{19} = \frac{\sin 25°}{12}$

(substituting the correct values in the correct places in the sin rule) M1

$ACB = 42°, 138°$ (both values) A1

(*b*) (i) $B\hat{A}C + 25° + 138° = 180°$

(f.t. either of candidate's values for ACB) M1

$B\hat{A}C = 17°$ (f.t. candidate's obtuse value for ACB) A1

(ii) Area of triangle $ABC = \frac{1}{2} \times 19 \times 12 \times \sin 17°$

(substituting 19, 12 and candidate's derived value for $B\hat{A}C$ in the correct places in the area formula) M1

Area of triangle $ABC = 33{\cdot}33\ \text{cm}^2$. (c.a.o.) A1

4. (*a*) (i) nth term $= 4 + 6(n-1) = 4 + 6n - 6 = 6n - 2$ (convincing) B1

(ii) $S_n = 4 + 10 + \ldots + (6n-8) + (6n-2)$

$S_n = (6n-2) + (6n-8) + \ldots + 10 + 4$

Reversing and adding M1

Either:

$2S_n = (6n+2) + (6n+2) + \ldots + (6n+2) + (6n+2)$

Or:

$2S_n = (6n+2) + \ldots$ (n times) A1

$2S_n = n(6n+2)$

$S_n = n(3n+1)$ (convincing) A1

(*b*) (i) $a + 9d = 4 \times (a + 4d)$ B1

$3a + 7d = 0$

$\frac{15}{2} \times (2a + 14d) = 210$ B1

$a + 7d = 14$

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

$d = 3$, $a = -7$ (c.a.o.) A1

(ii) $-7 + (k-1) \times 3 = 200$

(f.t. candidate's derived values for a and d) M1

$k = 70$ (c.a.o.) A1

5. (*a*) $r = \frac{2304}{576} = 4$ (c.a.o.) B1

$t_5 = \frac{576}{4^3}$ (f.t. candidate's value for r) M1

$t_5 = 9$ (c.a.o.) A1

(*b*) (i) $ar^2 = 24$ B1

$ar + ar^2 + ar^3 = -56$ B1

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

$\frac{r^2}{r + r^2 + r^3} = -\frac{24}{56} \Rightarrow 3r^2 + 10r + 3 = 0$ (convincing) A1

(ii) $r = -\frac{1}{3}$ ($r = -3$ discarded, c.a.o.) B1

$a = 216$

(f.t. candidate's derived value for r, provided $|r| < 1$) B1

$S_\infty = \frac{216}{1 - (-1/3)}$ (use of formula for sum to infinity)

(f.t. candidate's derived values for r and a) M1

$S_\infty = 162$ (f.t. candidate's derived values for r and a) A1

6. (*a*) $3 \times \frac{x^{1/2}}{1/2} - 6 \times \frac{x^{7/3}}{7/3} + c$ B1, B1
(–1 if no constant term present)

(*b*) (i) $6 + 5x - x^2 = 4x$ 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
$(x + 2)(x - 3) = 0 \Rightarrow x = 3$ (c.a.o.) A1

(ii) Use of integration to find the area under the curve M1
$\int 6\,dx = 6x$, $\int 5x\,dx = \frac{5x^2}{2}$, $\int x^2\,dx = (1/3)x^3$,
(correct integration) B1
Correct method of substitution of candidate's limits m1

$[6x + (5/2)x^2 - (1/3)x^3]_{-1}^{3}$

$= (18 + 45/2 - 9) - (-6 + 5/2 - (-1/3)) = 104/3$

Use of a correct method to find the area of the triangle (f.t. candidate's coordinates for A) M1
Use of -1 and candidate's value for x_A as limits and trying to find total area by subtracting area of triangle from area under curve m1
Shaded area = $104/3 - 18 = 50/3$ (c.a.o.) A1

7. (*a*) Let $p = \log_a x$, $q = \log_a y$
Then $x = a^p$, $y = a^q$ (the relationship between log and power) B1
$\frac{x}{y} = \frac{a^p}{a^q} = a^{p-q}$ (the laws of indicies) B1
$\log_a x/y = p - q$ (the relationship between log and power)
$\log_a x/y = p - q = \log_a x - \log_a y$ (convincing) B1

(*b*) $\log_a(6x^2 + 9x + 2) - \log_a x = \log_a \left(\frac{6x^2 + 9x + 2}{x}\right)$
(subtraction law) B1
$4 \log_a 2 = \log_a 2^4$ (power law) B1
$\frac{6x^2 + 9x + 2}{x} = 2^4$ (removing logs) M1
An attempt to solve quadratic equation with three terms in x, either by using the quadratic formula or by getting the expression into the form $(ax + b)(cx + d)$, with $a \times c$ = candidate's coefficient of x^2 and $b \times d$ = candidate's constant m1
$6x^2 - 7x + 2 = 0 \Rightarrow (2x - 1)(3x - 2) = 0 \Rightarrow x = {}^1/_2, {}^2/_3$
(both values, c.a.o.) A1
Note: Answer only with no working earns 0 marks

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

(ii) A correct method for finding radius M1

Radius = $\sqrt{29}$ (convincing) A1

(*b*) **Either:**

$RQ = \sqrt{18}$ or $RP = \sqrt{98}$ (o.e.) B1

Correct substitution of candidate's values in an expression for sin *Q*, cos *Q* or tan *Q* M1

$PQR = 66{\cdot}8°$ (c.a.o) A1

Or:

$RQ = \sqrt{18}$ or $RP = \sqrt{98}$ B1

Correct substitution of candidate's values in the cos rule to find cos *Q* M1

$PQR = 66{\cdot}8°$ (c.a.o) A1

(*c*) $AT^2 = 65$ (f.t. candidate's coordinates for *A*) B1

Use of $ST^2 = AT^2 - AS^2$ with candidate's derived value for *AT* M1

$ST = 6$ (f.t. one slip) A1

9. Area of sector $AOB = {}^1/_2 \times r^2 \times 2{\cdot}6$ B1

Area of triangle $AOB = {}^1/_2 \times r^2 \times \sin 2{\cdot}6$ B1

Area of minor segment $= {}^1/_2 \times r^2 \times 2{\cdot}6 - {}^1/_2 \times r^2 \times \sin 2{\cdot}6 = 1{\cdot}0422r^2$ B1

Use of a valid method for finding the area of the major segment M1

Area of major segment $= 2{\cdot}099r^2$

$\Rightarrow$ area of major segment $\approx 2 \times$ area of minor segment (convincing) A1