C2

1.

0	0·5		
0·5	0·470588235		
1	0·333333333		
1·5	0·186046511		
2	0·1	(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

$I \approx \frac{0{\cdot}5}{2} \times \{0{\cdot}5 + 0{\cdot}1 + 2(0{\cdot}470588235 + 0{\cdot}333333333 + 0{\cdot}186046511)\}$

$I \approx 2{\cdot}579936152 \times 0{\cdot}5 \div 2$

$I \approx 0{\cdot}644984038$

$I \approx 0{\cdot}645$ (f.t. one slip) — A1

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

0	0·5		
0·4	0·484496124		
0·8	0·398089172		
1·2	0·268240343		
1·6	0·164041994		
2	0·1	(all values correct)	B1

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

$I \approx \frac{0{\cdot}4}{2} \times \{0{\cdot}5 + 0{\cdot}1 + 2(0{\cdot}484496124 + 0{\cdot}398089172 + 0{\cdot}268240343 + 0{\cdot}164041994)\}$

$I \approx 3{\cdot}229735266 \times 0{\cdot}4 \div 2$

$I \approx 0{\cdot}645947053$

$I \approx 0{\cdot}646$ (f.t. one slip) — A1

Note: Answer only with no working earns 0 marks

2. (*a*) (i) Correct use of $\tan\theta = \frac{\sin\theta}{\cos\theta}$ (o.e.) — M1

Correct use of $\cos^2\theta = 1 - \sin^2\theta$ — M1

$6(1 - \sin^2\theta) + 5\sin\theta = 0 \Rightarrow 6\sin^2\theta - 5\sin\theta - 6 = 0$ (convincing) — A1

(ii) An attempt to solve given 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 $a \times c = 6$ and $b \times d = -6$ — M1

$6\sin^2\theta - 5\sin\theta - 6 = 0 \Rightarrow (3\sin\theta + 2)(2\sin\theta - 3) = 0$

$\Rightarrow \sin\theta = -\frac{2}{3}$, ($\sin\theta = {}^3/_2$) (c.a.o.) — A1

$\theta = 221{\cdot}81°, 318{\cdot}19°$ — B1 B1

Note: Subtract (from final two marks) 1 mark for each additional root in range from $3\sin\theta + 2 = 0$, ignore roots outside range.
$\sin\theta = -$, f.t. for 2 marks, $\sin\theta = +$, f.t. for 1 mark

(*b*) $2x - 60° = -38°, 38°, 322°$ (one value) — B1

$x = 11°, 49°$ — B1 B1

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

3. (*a*) Either: $(x + 2)^2 = x^2 + (x - 2)^2 - 2 \times x \times (x - 2) \times \cos B\hat{A}C$

Or: $\cos B\hat{A}C = \dfrac{x^2 + (x - 2)^2 - (x + 2)^2}{2 \times x \times (x - 2)}$

(substituting the correct expressions in the correct places in the cos rule) M1

Either: $\cos B\hat{A}C = \dfrac{x^2 + x^2 - 4x + 4 - x^2 - 4x - 4}{2 \times x \times (x - 2)}$ (o.e.)

Or: $\cos B\hat{A}C = \dfrac{x^2 + x^2 - 4x + 4 - x^2 - 4x - 4}{2x^2 - 4x}$ (o.e.) A1

$\cos B\hat{A}C = \dfrac{x - 8}{2x - 4}$ (convincing) A1

(*b*) (i) $\dfrac{x - 8}{2x - 4} = -\dfrac{1}{2}$ M1

$x = 5$ A1

(ii) **Either:**

$\dfrac{\sin ABC}{3} = \dfrac{\sin 120°}{7}$

(substituting the correct values in the correct places in the sin rule, f.t. candidate's value for x, provided $x > 2$) M1

$ABC = 21{\cdot}8°$

(f.t. candidate's value for x, provided $x > 2$) A1

Or:

$3^2 = 5^2 + 7^2 - 2 \times 5 \times 7 \times \cos ABC$

(substituting the correct values in the correct places in the cos rule, f.t. candidate's value for x, provided $x > 2$) M1

$ABC = 21{\cdot}8°$

(f.t. candidate's value for x, provided $x > 2$) 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:

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

(at least three terms, including those derived from the first pair and the last pair plus one other pair of terms)

Or:

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

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

$S_n = \dfrac{n}{2}[2a + (n - 1)d]$ (convincing) A1 (*b*) **Either:**

$\frac{10}{2}(2a + 9d) = 115$ B1

$S_{14} = 115 + 130$ M1

$\frac{14}{2}(2a + 13d) = 245$ A1

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

$a = -2$, $d = 3$ (both values) (c.a.o.) A1

Or:

$\frac{10}{2}(2a + 9d) = 115$ B1

$(a + 10d) + (a + 11d) + (a + 12d) + (a + 13d) = 130$ M1

$4a + 46d = 130$ (seen or implied by later work) A1

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

$a = -2$, $d = 3$ (both values) (c.a.o.) A1

5. (*a*) $r = 0{\cdot}8$ B1

$S_{18} = \frac{100(1 - 0{\cdot}8^{18})}{1 - 0{\cdot}8}$ M1

$S_{18} \approx 490{\cdot}992 = 491$ (c.a.o.) A1

(*b*) (i) $ar = -20$ B1

$\frac{a}{1 - r} = 64$ B1

An attempt to solve these equations simultaneously by eliminating a M1

$16r^2 - 16r - 5 = 0$ (convincing) A1

(ii) $r = -{}^{1}/_{4}$ (c.a.o.) B1

$|r| < 1$ E1

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

(– 1 if no constant present)

(*b*) (i) $x^2 + 3 = 4x$ 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 $a \times b = 3$ m1

$(x - 1)(x - 3) = 0 \Rightarrow x = 1, x = 3$ (both values, c.a.o) A1

Note: Answer only with no working earns 0 marks

(ii) Area of small triangle = 2

(any method, f.t. candidate's value for x_A) B1

Use of integration to find the area under the curve M1

$\int x^2 \, dx = (1/3)x^3$, $\int 3 \, dx = 3x$ (correct integration) B1

Correct method of substitution of candidate's limits m1

$$[(1/3)x^3 + 3x]_1^3 = (9 + 9) - (1/3 + 3) = 44/3$$

Use of candidate's values for x_A and x_B as limits and trying to find total area by adding area under curve to area of triangle

m1

Shaded area = 44/3 + 2 = 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

$xy = a^p \times a^q = a^{p+q}$ (the laws of indices) B1

$\log_a xy = p + q$ (the relationship between log and power)

$\log_a xy = p + q = \log_a x + \log_a y$ (convincing) B1

(*b*) **Either:**

$(2 - 3x) \log_{10} 5 = \log_{10} 8$

(taking logs on both sides and using the power law) M1

$x = \dfrac{2 \log_{10} 5 - \log_{10} 8}{3 \log_{10} 5}$ A1

$x = 0{\cdot}236$ (f.t. one slip, see below) A1

Or:

$2 - 3x = \log_5 8$ (rewriting as a log equation) M1

$x = \dfrac{2 - \log_5 8}{3}$ A1

$x = 0{\cdot}236$ (f.t. one slip, see below) A1

Note: an answer of $x = -0{\cdot}236$ from $x = \dfrac{\log_{10} 8 - 2 \log_{10} 5}{3 \log_{10} 5}$

earns M1 A0 A1

an answer of $x = 1{\cdot}097$ from $x = \dfrac{2 \log_{10} 5 + \log_{10} 8}{3 \log_{10} 5}$

earns M1 A0 A1

an answer of $x = 0{\cdot}708$ from $x = \dfrac{2 \log_{10} 5 - \log_{10} 8}{\log_{10} 5}$

earns M1 A0 A1

Note: Answer only with no working shown earns 0 marks

(*c*) $\frac{1}{2}\log_a 144x^8 = \log_a 12x^4$ (power law) B1

$\log_a 90x^2 - \log_a \left(\frac{5}{x}\right) = \log_a \left(\frac{90x^2 \times x}{5}\right)$ (subtraction law) B1

$\frac{90x^2 \times x}{5} = 12x^4$ (removing logs, f.t one incorrect term) B1

$x = 1{\cdot}5$ (c.a.o.) B1

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

A correct method for finding the radius M1

Radius = 5 A1

(*b*) (i) Showing that the coordinates of A do not satisfy the equation of L (f.t. candidate's coordinates for A) B1

(ii) An attempt to substitute $(9 - x)$ for y in the equation of C_1 M1

$x^2 - 5x + 6 = 0$ (or $2x^2 - 10x + 12 = 0$) A1

$x = 2, x = 3$

(correctly solving candidate's quadratic, both values) A1

Points of intersection are (2, 7), (3, 6) (c.a.o.) A1

(*c*) Distance between centres of C_1 and C_2 = 13

(f.t. candidate's coordinates for A) B1

Use of the fact that the shortest distance between the circles = distance between centres – sum of the radii M1

Shortest distance between the circles = 2

(f.t. candidate's coordinates for A and radius for C_1.) A1

9. (*a*) Substitution of values in area formula for triangle M1

Area = $\frac{1}{2} \times 7{\cdot}2^2 \times \sin 1{\cdot}1 = 23{\cdot}1 \text{ cm}^2$. A1

(*b*) Let $B\hat{O}C = \phi$ radians

$\frac{1}{2} \times 7{\cdot}2^2 \times \phi = 19{\cdot}44$ M1

$\phi = 0{\cdot}75$ (o.e.) A1

Length of arc $BC = 7{\cdot}2 \times 0{\cdot}75 = 5{\cdot}4$ cm

(f.t. candidate's value for ϕ) A1